2021

CO-TEACHING PRACTICES OF GENERAL AND SPECIAL EDUCATORS IN SECONDARY SCIENCE CLASSROOMS

Samantha Jolene Ringl
University of Kentucky, sringlscience@gmail.com
Author ORCID Identifier:
https://orcid.org/0000-0002-7547-4206
Digital Object Identifier: https://doi.org/10.13023/etd.2021.267

STUDENT AGREEMENT:

I represent that my thesis or dissertation and abstract are my original work. Proper attribution has been given to all outside sources. I understand that I am solely responsible for obtaining any needed copyright permissions. I have obtained needed written permission statement(s) from the owner(s) of each third-party copyrighted matter to be included in my work, allowing electronic distribution (if such use is not permitted by the fair use doctrine) which will be submitted to UKnowledge as Additional File.

I hereby grant to The University of Kentucky and its agents the irrevocable, non-exclusive, and royalty-free license to archive and make accessible my work in whole or in part in all forms of media, now or hereafter known. I agree that the document mentioned above may be made available immediately for worldwide access unless an embargo applies.

I retain all other ownership rights to the copyright of my work. I also retain the right to use in future works (such as articles or books) all or part of my work. I understand that I am free to register the copyright to my work.

REVIEW, APPROVAL AND ACCEPTANCE

The document mentioned above has been reviewed and accepted by the student's advisor, on behalf of the advisory committee, and by the Director of Graduate Studies (DGS), on behalf of the program; we verify that this is the final, approved version of the student's thesis including all changes required by the advisory committee. The undersigned agree to abide by the statements above.

Samantha Jolene Ringl, Student

Dr. Jennifer Wilhelm, Major Professor

Dr. Molly Fisher, Director of Graduate Studies

CO-TEACHING PRACTICES OF GENERAL AND SPECIAL EDUCATORS IN SECONDARY SCIENCE CLASSROOMS

DISSERTATION

A dissertation submitted in partial fulfillment of the
requirements for the degree of Doctor of Philosophy in the
College of Education
at the University of Kentucky

By
Samantha Jolene Ringl
Lexington, Kentucky
Director: Dr. Jennifer Wilhelm, Professor of Science, Technology, Engineering, and Mathematics Education
Lexington, Kentucky
2021

https://orcid.org/0000-0002-7547-4206

ABSTRACT OF DISSERTATION

CO-TEACHING PRACTICES OF GENERAL AND SPECIAL EDUCATORS IN SECONDARY SCIENCE CLASSROOMS

The purpose of this study was to establish current levels of co-teaching implementation and to explore teachers' perceptions of co-teaching and co-teacher relationships. This study also examined whether there is a relationship between teachers' perception of their co-teaching relationship and their perception of co-teaching implementation in their classrooms. Analysis revealed that teachers generally have positive perceptions of their co-teaching partners and relationships, and these perceptions did not significantly differ between science teachers and special educators. However, this study found that teachers are not regularly planning lessons together, sharing the workload in the classroom, or choosing co-teaching models together. This study did not find a significant relationship between teacher perception of their co-teaching relationships and their perception of co-teaching implementation.

KEYWORDS: Co-Teaching, Science Education, Secondary Science, Inclusive Science Classrooms

Samantha Jolene Ringl
(Name of Student)

06/24/2021
Date

CO-TEACHING PRACTICES OF GENERAL AND SPECIAL EDUCATORS IN SECONDARY SCIENCE CLASSROOMS

By
Samantha Jolene Ringl

Dr. Jennifer Wilhelm
Director of Dissertation

Dr. Molly Fisher
Director of Graduate Studies

06/24/2021
Date

DEDICATION

I dedicate this dissertation to my Granny June who was always an excellent role model and inspiration.

ACKNOWLEDGMENTS

The following dissertation, while an individual work, benefited from the insights and direction of several people. First, my Dissertation Chair, Dr. Jennifer Wilhelm, truly taught me how to be a scholar and a faculty member. Next, I wish to thank the complete Dissertation Committee, and outside reader, respectively: Dr. Rebecca Krall, Dr. Molly Fisher, Dr. Kera Ackerman, and Dr. Stephanie Stockburger. Without their constant guidance, feedback, and support this project would have never been completed.

I would like to sincerely thank my husband, Jonas Ringl, for his love, support, and sacrifices throughout this journey. I am thankful for his partnership and that he encouraged me to work toward this degree. I would also like to thank my parents, Woodrow and Rebecca Mullins, for teaching me what it means to work hard, and for their unwavering support. I would also like to thank my mother and father-in-law, Thomas and Janet Ringl, for always treating me like their daughter and supporting our family in so many ways.

Finally, I wish to thank the respondents of the survey and the interview participants (who remain anonymous for confidentiality purposes).

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1. **INTRODUCTION**

1.1 Introduction

I taught secondary science courses at three different Kentucky high schools and my experiences co-teaching in these schools brought me to this study. Only one of the schools offered any sort of training for co-teaching and it was in the form of a two separate day long professional developments. My partner and I sat through a few hours of lecture and activities, and then we were allowed to attempt to plan a lesson together. Other than those two days, we were not given any dedicated time outside the classroom to plan together. I was lucky in that my partner at this school was very motivated to teach the course with me. She, rightfully, did not see herself as my assistant, but as an equal in my classroom and both I and the students saw her that way. We planned between classes and via email, but we could have been an excellent team if we had been allowed time to figured out how best to co-teach. At the two other schools, co-teaching teams were not so lucky. Scheduling conflicts always had special education teachers splitting class periods which means they were only allowed to be in the science class for up to half of the class time. At the last school I worked at before beginning the journey toward this dissertation, my co-teacher believed his role was to check on the students on his case load at the beginning of class, then leave to take care of other things. The situation was similar for the science co-teaching team in the first school I worked in.

Out of three experiences with co-teaching, only one school was making an active effort to support co-teaching teams, and this still did not feel like enough support at the time. These experiences made me very curious as to whether other science teachers were facing similar problems. I also wanted to gain the perspective of special education teachers

as I felt that I understood problems facing science teachers but did not have enough knowledge of the time constraints, responsibilities, and skills of special educators to speak on their role in the co-taught classroom. It is important to note that I am biased toward the views and roles of a science teacher, but I highly value the skills and knowledge that the special educator can bring to a co-teaching partnership.

The Individuals with Disabilities Education Act (IDEA, 2004) mandates that students with disabilities be educated in their least restrictive environments. For students in special education, this means that they are in a regular classroom with their peers in general education as much as possible. Research has shown that including students with special needs in classrooms with their general education peers benefits students with disabilities (Phelan, 2018; Walther-Thomas, 1997). Walther-Thomas (1997) studied 119 teachers as part of co-teaching teams in eight different districts in Virginia. Based on data from the interview portion of the mixed methods study, the teachers reported benefits of inclusion for students in special education such as increased self-confidence, increased self-esteem, improved social skills, and improved academic performance. Teachers also reported that student independence increased because of the teachers' efforts to prevent students in special education from feeling singled out. This was accomplished by checking on or helping non-identified students first before moving on to help the identified students (Walther-Thomas, 1997). Phelan (2018) conducted interviews with ten middle school general education science teachers and five special education teachers in Missouri and found that in the opinion of the teachers, students in special education benefit not only academically but also in a social capacity from increased interactions with their peers in general education.

To accommodate students with disabilities in general education classrooms, teams consisting of the parents, special education professionals, educators, administrators, and the student will come together to form an individualized education program (IEP). The IEP consists of learning goals and accommodations that will help the student to succeed in classes and on standardized testing. Students in special education are provided accommodations and goals in their IEPs and placed with their general education peers for science courses at the secondary level which adheres to the guidelines set forth in IDEA. This poses unique challenges to science content teachers as they must learn to differentiate their curriculum to meet the needs of students with a wide range of ability levels. As students benefit so greatly from inclusion, it is imperative that science educators meet those challenges. A solution called for on many students' IEPs is co-teaching in which students have access to both the science teacher and a special educator within the same classroom.

1.2 Background

The achievement gap between students identified as having special needs and students in general education is significant. Special education teachers and districts in the United States have been mandated to close the gap through national programs such as No Child Left Behind (NCLB) and Every Student Succeeds Acts (ESSA) of 2015. Research has shown that this gap has remained, even though schools are threatened with a loss of funding and intense pressure is placed upon special education teachers to drive their students toward higher test scores (Schulte & Stevens, 2015; Minthrop & Zane, 2017).

Despite the national push for more inclusive classrooms and research showing that students benefit academically and socially from inclusion, an achievement gap remains between students identified as having disabilities and students not identified as having

disabilities. Table 1 contains data from the National Assessment of Educational Progress assessment of grade eight science and illustrates this gap (National Center for Education Statistics, 2015).

Table 1.1 Average scale score comparison between students identified as having disabilities, including those with a 504 Plan, and students not identified as having disabilities based on 2015 NAEP data for grade 8 science

	Student Classification	Average Scale Score	Difference within Groups	Significance
National Public Schools	Students Identified as Having Disabilities	123	29	<0.001
	Students Not Identified as Having Disabilities	152		
Kentucky Public Schools	Students Identified as Having Disabilities	137	23	<0.001
	Students Not Identified as Having Disabilities	160		

Within national public schools across the United States, students identified as having disabilities scored twenty-nine points lower than their peers on the science assessment. Within Kentucky, students identified as having disabilities scored twenty-three points lower than their peers. These differences were shown to be significant ($p<0.001$) (National Center for Education Statistics, 2015).

In Kentucky, the achievement gap remains evident in secondary science classes. Table 2 contains data from the 2018-2019 Kentucky Performance Rating for Educational Progress (K-PREP) science assessment. This standardized test is administered to 11th grade science students each year (Kentucky Department of Education, 2020).

Table 1.2 Percentage of students in Kentucky scoring at each level on the statewide secondary science assessment for school year 2018-2019

	N	A	P	D	P + D
Students with an IEP (*N*=4,322)	46.9	44.8	7.9	0.4	8.3
Students with an IEP Tested on Regular Standards (*N*=3742)	50.5	44.2	5.2	0.1	5.3
Students with an IEP Tested on Alternate Standards (*N*=580)	23.6	49.0	25.0	2.4	27.4
Students with no identified disabilities (*N*=41,916)	18.2	49.7	29.8	2.3	32.1
State Total (*N*=46,238)	20.9	49.2	27.8	2.1	29.9

Note. N = Novice, A = Apprentice, P = Proficient, D = Distinguished, and P + D = Proficient and Distinguished.

Nearly half (46.9%) of students with an IEP scored at the novice level and only 8.3% of students scored proficient or distinguished. In comparison, 32.1% of students with no identified disabilities (no IEP) scored proficient or distinguished (Kentucky Department

of Education, 2019). Measures of significance were not reported for this data, but it is obvious that students with disabilities are not performing at the same level as their peers without disabilities in science.

1.2.1 Students with Special Needs in Secondary Science

Science can be challenging for students with special needs. Often, courses such as secondary biology require students to read complex texts, use mathematics skills, and construct arguments based on evidence from a scientific investigation. Many students with special needs already struggle in those areas, particularly reading and math, and struggle further when asked to apply these skills in their science courses.

It can be difficult to adequately meet the needs of a diverse group of learners and science teachers may have insufficient knowledge of the various learning disabilities they will encounter. In a survey of 1,088 K-12 science teachers, responses indicated that teachers did not feel adequately prepared to teach students with disabilities and only 7.7% of respondents had taken a science methods course or a specific training related to teaching science to students with special needs (Kahn & Lewis, 2014). Similarly, Mumba et al. (2015) surveyed sixty-one secondary chemistry teachers across the United States and found that all of the surveyed teachers either agreed or strongly agreed that a lack of training in special education made it more difficult to teach an inquiry-based unit in a classroom containing students of all ability levels. In a study of six general education teachers, Rice (2017) found that teachers believe that co-teaching and professional development on working with students with disabilities were essential to successfully teaching a classroom with varied ability levels. Van Garderen et al. (2012) found that general education teachers may be unprepared to address the needs of the variety of learners and disabilities they may

encounter in their classrooms. They proposed a new professional development model (PD) that combines practices from both content teachers and special education teachers into one PD to help teach science through inquiry in an inclusive way (Van Garderen et al., 2012).

Riedell (2018) conducted case studies of three eighth grade science teachers and found that the science teachers were differentiating curriculum in their classrooms, but they were more focused on strategies for whole group instruction. They sought ways to make their instruction more engaging and hands-on for their students, but they did not attempt to individualize instruction for each student (Riedell, 2018). In a study of seven secondary science teachers, Maeng and Bell (2015) found that science teachers were attempting to differentiate their curriculum but most of the strategies used were simple and required little planning or personalization such as graphic organizers. It was also noted that it was rare to observe more than one type of differentiation in a single lesson. The authors recommend professional development focused on differentiation as training seems inadequate. Science teachers will inevitably have the opportunity to teach students with special needs, but the cited studies on differentiation in secondary science suggest teachers need more training to be comfortable or effective at teaching students with special needs.

A possible solution to these challenges is collaboration with a special education teacher to increase access to differentiation strategies and knowledge of teaching students with disabilities. Mnemonic devices, inquiry-based learning, and other differentiation strategies have been shown to positively impact the ability to remember science facts and vocabulary by students in special education (Therrien et at., 2011). Co-teaching with a special education teacher could help science teachers implement these differentiation strategies in their instruction. Watt, Therrien, Kaldenberg, and Taylor (2013) also found

that the co-teaching setting was a good environment for inquiry-based science education because co-teaching pairs could provide an increased range of student supports. Co-teaching, particularly co-teaching that is done before a lesson to provide a student with learning disabilities an opportunity to learn key vocabulary and facts before a lesson, has been shown to increase student success during a lesson in the general education setting (Thornton et al., 2015).

Students' IEPs may call for a set number of co-teaching minutes per week in science courses which means that a special education teacher is required to be in the classroom with the science teacher for a set amount of time. However, the required minimum times may be inadequate for building the kind of relationships that make collaborative teaching successful. Simon (2018) found that for coteaching to be successful, teaching teams needed common planning time, adequate training, and a positive attitude toward coteaching. The researcher states that simply putting two teachers into a classroom is ineffective (Simon, 2018). Linz, Heater, and Howard (2008) made the important point that personalities and experiences should be considered when administrators choose collaborative teams. Department heads, teachers, and principals should work together to assess both general and special education teachers' personality traits to assign the best teams. If the two teachers do not have the skills to work together, then student outcomes will suffer (Linz et al., 2008).

Cook and Friend (1995) described the different models of collaboration and in some school districts, these models are used as the basis for professional development. Research has shown that the most effective model is team teaching in which both teachers lead the classroom as equals. However, the most commonly seen model in practice is one-teach,

one-assist in which the content teacher acts as the leader and the special education teacher acts as an assistant (Dieker & Rodriguez, 2013). It is important to note that practices outside the classroom, such as planning together, are also important for collaboration to be successful (Simon, 2018).

1.3 Statement of the Problem

Research has shown that co-teaching is not being effectively implemented in science classrooms (Dieker & Rodriguez, 2013; King-Sears et al., 2014). Without proper interventions such as co-teaching to increase differentiation in classrooms, the achievement gap between students in special education and students in general education will remain significant (Schulte & Stevens, 2015). It is important to understand the reasons behind this lack of proper implementation. By gaining the teachers' perspectives on co-teaching, it is hoped that sound arguments for needed supports can be made to district leadership. This dissertation seeks to determine the extent to which secondary science teachers are practicing co-teaching with a special education teacher in their classrooms. It also seeks to understand the challenges that co-teaching pairs face when it comes to successful implementation. Co-teaching has the potential to increase positive student learning outcomes and decrease the achievement gap between students in special education and students in general education. The purpose of this study is to establish the current levels of co-teaching implementation so that student outcomes in classrooms with successful co-teaching may be studied in the future.

1.4 Research Questions

The following research questions were developed to guide the study:

1. How to teachers perceive the co-teaching relationships and implementation of co-teaching in their classrooms? How do general and special educators' perceptions of co-teaching differ?

2. To what extent are secondary science teachers practicing co-teaching with a special education teacher in their classrooms?

3. How do teachers' perceptions of their co-teaching relationships affect the Implementation of co-teaching?

To examine these questions, a mixed methods study using questionnaires and one-on-one interviews will be implemented. Participants will be secondary science co-teachers, both general and special educators, from across Kentucky.

1.5 Theoretical Framework

Situated Learning Theory (SLT) states that learning is contextualized by the setting, activity, and culture in which it occurs. Learning must be situated in the context in which the knowledge is to be applied (Lave & Wenger, 1991). Situated learning is not always intentional as participants will gradually learn skills from interacting with and observing more skilled community members (Lave & Wenger, 1991). Co-teaching pairs will not likely come together to teach each other the science content, differentiation skills, or the varied types of learning disabilities in the classroom. Instead, each partner will gradually pick up skills and knowledge from their daily interactions and observations until they are both skilled in the other's domain. The partners will, however, ideally form a community of practice (Wenger, 1998) in which they work together to plan lessons, differentiate instruction, and create an inclusive environment for all students.

1.6 Study Significance

Much of the identified literature focuses on best practices related to co-teaching and methods for working successfully as a collaborative teaching pair (Dieker & Rodriguez, 2013; Gately & Gately, Jr., 2001; Ploessl et al., 2010; Linz et al., 2008). However, the identified literature is rarely accompanied by data to support claims. Few empirical studies related to the level at which secondary science teachers and special educators are collaborating were located. This study seeks to establish current trends in collaborative teaching practices in secondary science as well as the challenges to implementation as identified by co-teaching pairs. Participants in this study will be given the opportunity to share possible solutions to challenges they are facing in their classrooms related to co-teaching which will provide ideas for further research. By establishing the baseline of current practices, future research can focus on methods of increasing implementation of successful collaborative teaching and then on student learning outcomes from classes with successful co-teaching.

1.7 Instruments

Instruments used in this study include two surveys and an interview protocol. The two surveys, The Co-Teacher Relationship Scale (CRS) (Noonan et al., 2003), and the Are We Really Co-Teachers Rating Scale (AWRCT) (Villa et al., 2013) will be combined to send participants one link from Qualtrics. Both surveys have been converted to five-point Likert scales by other researchers (Cramer & Nevin, 2006; Ricci et al., 2019) and this format will be used in this study. The scale for the CRS ranges from 1 (very different) to 5 (very similar) and asks participants to select the best choice for how similar they feel to their co-teacher for each of the 19 items on the survey (Cramer & Nevin, 2006). The scale

for the AWRCT ranges from 1 (Once a Week or Less) to 5 (daily actions) and asks participants to indicate how often they implement co-teaching practices for the 35 items on the survey (Ricci et al., 2019). The protocol in this study was developed by the researcher and is intended to be used to gain more information about survey responses and teachers' ideas about co-teaching practices.

1.8 Definition of Key Terms

A number of key terms must be defined as they relate to this study.

General Education Teacher: The general education teachers in this study will be the secondary science content teachers. They are licensed, professional teachers.

Special Education: The education of exceptional children which includes students with disabilities as well as students identified as gifted and/or talented (Heward et al., 2017).

Special Education Teacher: The special educators in this study are licensed teachers with degrees in special education. Interpreters, scribes, readers, and paraprofessionals are excluded from this study.

Co-teaching: Co-teaching may be defined as occurring when two professional educators work together to provide quality instruction to a classroom of students with diverse abilities and needs (Cook & Friend, 1995). Co-teaching partners in this study will be general education secondary science teachers and licensed special educators.

Students with Disabilities: Students identified as having one or more learning, developmental, or behavioral disabilities that require extra supports to be successful in the classroom (Heward et al., 2017).

Differentiation: Differentiation may be defined as the process by which teachers alter their instruction, curricula, classroom environments, and assessments in order to meet the needs of all students (Tomlinson & Imbeau, 2010).

1.9 Summary

This introduction provides the background information necessary to understand the importance of co-teaching and the inclusion of children with disabilities in the science classroom. Collaborating and co-teaching with special educators can help secondary science teachers better differentiate their instruction for a variety of student needs. Having two teachers in the classroom opens new opportunities for teaching strategies such as station teaching and parallel teaching which can effectively lower the teacher to student ratio in a classroom.

The purpose of the study, as discussed in this introduction, is to understand the level of co-teaching that occurs in secondary science classrooms in Kentucky. Much of the literature surrounding science and co-teaching focuses on best practices and suggestions for how to implement co-teaching. Therefore, a new baseline must be established to determine if teachers are implementing these best practices. Teachers will also be asked to evaluate their own co-teaching practices and to suggest solutions for challenges.

Co-teaching in inclusive secondary science classrooms has the potential to greatly benefit all students, not just students with disabilities. Students of all ability levels would benefit from a lower teacher to student ratio and better differentiated curriculum. Most importantly, co-teaching has the potential to decrease the achievement gap between students in general education and students in special education. This study seeks to

determine whether co-teaching is being implemented in Kentucky schools and future research will seek to determine how to improve co-teaching practices in schools so that student outcomes may be measure

CHAPTER 2. LITERATURE REVIEW

2.1 Theoretical Framework

The theoretical framework this study relies upon originated in Situated Learning: Legitimate Peripheral Participation (Lave & Wenger, 1991) and was expanded upon in Communities of Practice: Learning, Meaning, and Identity (Wenger, 1998). Situated Learning Theory (SLT) states that learning must be situated in the context in which the knowledge is to be applied, meaning it is contextualized by the setting, activity, and culture in which it occurs. (Lave & Wenger, 1991). Situated learning is not always intentional as participants will gradually learn skills from interacting with and observing more skilled community members which is the foundation of legitimate peripheral participation (Lave & Wenger, 1991).

One must understand the meaning of Legitimate Peripheral Participation (LPP) to fully understand Situated Learning Theory (SLT). LPP is a method of participation or learning in which the participant gradually increases their knowledge or expertise by first observing experts then gradually increasing participation in the community until they too are viewed as experts. (Lave & Wenger, 1991). When one is an apprentice to a master, the master does not immediately let the apprentice fully participate in the skilled activity. Gradually, as the apprentice becomes more knowledgeable by watching and interacting with the master, they become a more skilled worker. Applied to teaching, this concept can be seen in the practice of student teaching experiences in which control is gradually given to the student-teacher as they learn more about teaching from the lead teacher.

2.1.1 Communities of Practice

An important aspect of SLT and LPP is the presence of a community of practice. A community of practice can be defined as a group of people who share a common practice and become better at that practice through regularly interacting with one another (Wenger, 1998). As such, communities of practice promote social learning and innovation within the practice. For a community of practice to be legitimate, it needs to have three defining features: a domain, a community, and a shared practice. The domain is a shared competence or skillset such as a skilled trade (e.g. plumbing) or teaching. The community of practice must have some shared skillset that distinguishes it from the rest of the population (Wenger, 1998). The community must have members that are seeking to engage in a joint interest. The members have discussions, participate in activities, share information, and help each other improve (Wenger, 1998). Finally, a community of practice must have a practice or a shared activity with shared resources, stories, experiences, tools, and methods of problem-solving (Wenger, 1998). As long as these conditions are met, members of the community of practice benefit from their interactions and truly better their practices by learning from each other.

Applied to coteaching, the community of practice would form between the general education teacher and the special education teacher. The domain is science teaching within diverse classrooms, the community forms between the co-teachers, and the practice is co-teaching. As the pair of teachers work together and have conversations around the practice of coteaching, it stands to reason that they would improve their co-teaching skills. The secondary science teacher can gain knowledge of teaching students in special education such as appropriate differentiation strategies and strategies for mitigating behavioral

problems. The special educator stands to gain content knowledge and teaching strategies for delivering the content knowledge. When these two professionals work together on a successful team, instruction should be enhanced by the shared body of knowledge.

2.1.2 Supporting Literature

Several articles and studies related to co-teaching, particularly as a method for teacher education, have relied upon SLT as their theoretical framework (Eick et al., 2003; Guise et al., 2017; Korthagen, 2010). In a study of 10 secondary science methods students in the field component of their methods course, Eick et al. (2003) stated that the students were legitimate peripheral participants in their placement classrooms. The researchers found that by having the students first observe the cooperative teachers' lessons plan during first period, then having the students teach the lesson plan in the next period, the students became much more confident and comfortable in the classroom. Korthagen (2010) proposes that for teacher practice to be impacted by teacher education, all learning must be situated and contain real-world examples. The author argues that traditional approaches to teacher education such as presenting educational theories is ineffective if not grounded by examples and opportunities to practice or apply the theories. Presenting theory alone is in conflict with principles of SLT but theory can be an important part of teacher education as students become comfortable with teaching practices (Korthagen, 2010).

While science teachers may have learned about accommodations or modifications for students with disabilities in methods courses or conversations with colleagues, SLT supports the idea that science teachers need to see these practices in science lesson specific contexts. As stated by Eick et al. (2003), "much of the knowledge for teaching cannot be learned out of context and later applied in classrooms." (p.75). This notion also applies to

special educators in that they may not have seen many of their strategies and skills applied to science lessons. Co-teaching can help both teachers learn new skills situated in the context in which they will be used. Eick et al. (2003) support this idea by stating, "Coteaching allowed students to observe and test out new strategies, management procedures, and styles used by their classroom teacher." (p.82).

According to Guise et al. (2017), "successful implementation of co-teaching involves mutual engagement, joint enterprise, and shared repertoire, three aspects of a community of practice." (p.372). The researchers conducted a study of eight secondary level co-teaching pairs consisting of a pre-service teacher and a cooperating mentor teacher. Four of the pairs were in secondary science classrooms and the other four pairs were in secondary English classrooms. The participants had all undergone training on co-teaching prior to the study. The researchers expected to see a community of practice form between the pre-service teacher and mentor teacher as they worked together to co-teach the class. However, in the science classrooms, three of the four pairs were observed to implement traditional student teaching in which the pre-service teacher helps or observes with few opportunities to lead the class. In these instances, the pre-service teachers reported feeling intimidated and undervalued by their cooperating teacher. A community of practice did not form because the cooperating teachers did not value the input of the pre-service teachers and did not often invite them to lead activities or lectures.

2.1.3 Applied to This Study

As co-teachers are meant to work together and learn from each other, the theoretical framework for this study will be a combination of Situated Learning Theory (Lave & Wenger, 1991) and Communities of Practice (Wenger, 1998). This framework was chosen

because a true co-teaching relationship will have the science teacher and the special education teacher on equal footing as both masters and apprentices. Often, science teachers are not trained for teaching students with disabilities (Mumba et al.,2015) and special education teachers are not always comfortable with science content or pedagogy.

As partners work together, they should experience legitimate peripheral participation (Lave & Wenger, 1991). That is, they should learn skills from their co-teaching partner such as differentiation strategies, behavior management strategies, content knowledge, or knowledge of student disabilities and accommodations. Co-teaching pairs will not likely come together to teach each other the science content, differentiation skills, or the varied types of learning disabilities in the classroom. Instead, each partner will gradually pick up skills and knowledge from their daily interactions until they are both skilled in the other's domain. As the survey and observation instruments indicate, co-teachers should ideally share similar views on teaching, should have the common goal of providing the best learning environment for all students, and should demonstrate effective communication to maintain best practices or improve instruction.

2.2 The Case for Inclusion

Students should not be excluded from a secondary science classroom because of mild to moderate disabilities. With the right accommodations and a supportive environment, students in special education should be allowed to master the science standards so that they are as well prepared as their general education peers to process scientific information and think critically about the world around them.

Thirteen percent of school-aged children are identified as having disabilities and of those students, forty percent are identified as having two or more disabilities (Heward et

al., 2017). Students of color and students of low socioeconomic status are disproportionately identified as needing special education services (Skiba et al., 2008; Heward et al., 2017). Science teachers must ensure that these students have access to the same quality science education as their general education peers. Much has been written on the benefits of placing all students in their least restrictive environments such as the development of social skills and empathy in students in special education after interreacting with their peers in general education (Dymond et al., 2006; Phelan, 2018; Walther-Thomas, 1997). Dymond et al. (2006) conducted a case study on a team of school personnel as they redesigned a secondary science course to focus on inclusion. The school faculty used the principles within Universal Design for Learning (UDL) as UDL promotes a flexible curriculum that allows for better inclusion. The researchers found that course redesign to promote inclusion was possible but, to be successful, faculty must properly support the students by providing access to scaffolding and structure for redesigned activities (Dymond et al., 2006).

2.3 Differentiating Curriculum

Students in special education are often held to the same standards as their general education peers. As one might imagine, general education science teachers face many challenges when attempting to provide quality instruction to all students in a mixed-ability classroom. Differentiation is the key to a truly inclusive education environment. A detailed definition of differentiation was found in Tomlinson and Imbeau's book, Leading and Managing a Differentiated Classroom (2010).

Table 2.1 Key aspects of differentiated instruction (Tomlinson and Imbeau, 2010)

Content	Process	Products	Learning Environment
Varying the material the students need to learn or the ways in which students access the materials (varying reading levels, varying teaching style)	Varying the types of activities students will do to learn the material (length of time, access to manipulatives, offering challenges)	Giving students options for how they will demonstrate their learning (varying types of assessments)	Ensuring students have the environment they need to succeed (quiet areas vs areas for collaboration, materials from other cultures/languages, allowing students to move as needed, structured setting with clear rules)

Differentiation may then be defined as the process by which science teachers ensure that the curriculum, learning process, assessments, and learning environment have enough variation to accommodate a wide range of learners. Science teachers must learn to differentiate their curriculum and use a variety of strategies to meet the needs of all learners in their classrooms.

The purpose of differentiation is to provide equitable supports for students to ensure that all students succeed. However, despite the push for differentiation, an achievement gap exists between students identified as having disabilities and students not identified as

having disabilities. Schulte and Stevens (2015) completed a longitudinal study in which they looked at mathematics achievement data from a cohort of 92,045 students in one state from the third grade through the seventh grade. Students were divided into two groups, students with disabilities, and students without disabilities. The researchers found that no matter how they approached statewide math achievement data, either longitudinally or via cross-section, an achievement gap remained between students with disabilities and students in general education. The authors also used a multilevel growth model to determine that students with disabilities experienced growth more slowly than students in general education, thus the achievement gap increased from the third grade through the seventh grade. However, they found that when students were tracked as they moved from special education into general education rather than only considering students currently in special education, the achievement gap was reduced, though still significant (Schulte & Stevens, 2015). These findings suggest that without further intervention, such as better or increased training for differentiation, the achievement gap will remain.

2.3.1 Best Practices for Differentiating Science Instruction for Students with Disabilities

Section 504 of the Rehabilitation Act of 1973 guarantees the right to a free and appropriate education for all students, regardless of disability status (U.S. Department of Education, 2010). All students deserve a science education and students with disabilities should not be excluded from the general education science classroom. Although teachers may find it challenging to design an inclusive classroom and curriculum, several strategies and guidelines can be found in the literature including Universal Design for Learning, High Leverage Practices, evidence-based practices, and co-teaching with a special education teacher.

2.3.1.1 Universal Design for Learning

Price et al. (2012) proposed several potential barriers to science learning in students with disabilities such as the overwhelming nature of open inquiry, difficult scientific vocabulary, following detailed directions, and difficulty interpreting and communicating numerical data. To overcome these barriers, teachers can use the Universal Design for Learning (UDL) framework to design more inclusive instruction. The Center for Applied Special Technology (CAST) describes three main principles behind UDL: multiple means of engaging students, multiple means of comprehension or representation, and multiple means of expression or assessment (CAST, 2018).

Multiple means of engagement in science should include strategies that lead to student collaborations, self-monitoring, and active interest (Baurhoo & Asghar, 2014; CAST, 2018). This could include providing links to the community within the content, having students monitor their own learning goals, and having students work together to solve problems. Multiple means of expression includes providing different options for how students access and interact with materials. For example, instead of simply providing daily readings which create barriers for students with reading disabilities, teachers should also provide audio or video representations of the information in the text. Giving students options that will help access the material is key. Allowing multiple means of expression or assessment will enable students to express their learning in the way that works best for them. Teachers could have students complete a project, a traditional test, a graphic organizer, an oral presentation or performance, or whatever form of assessment a student is comfortable with as long as it allows the teacher to assess the student's learning.

UDL is an excellent framework for ensuring that a class is inclusive of all students. Giving students multiple options for engagement, learning, and expression will allow more students to be successful. Teacher flexibility is important in UDL because teachers have to understand and be willing to work with students' diverse needs. Science courses have the potential to work particularly well for UDL in that teachers can design most course to follow a structured inquiry or project-based format in which the teacher provides a real-world problem, phenomenon, or driving question that the students are allowed to use the methods that work best for them to go about completing the unit.

2.3.1.2 High Leverage Practices

High Leverage Practices (HLP) are a series of effective strategies shown to positively impact student learning, student social development, and student emotional development. According to TeachingWorks (2020), there are 19 HLPs for general education teachers that are considered essential skills for every teacher. The HLP Writing Team (2017) determined that there are 22 HLPs for special educators but they state that these HLPs build off the HLPs for general educators though they are more detailed and contain practices specific to special education. HLPs for general educators include leading a group discussion, modeling content, interpreting student thinking, and providing feedback to students. (TeachingWorks, 2020). HLPs for special educators include collaborating with other professionals, using assessments to understand student strengths and needs, and providing feedback to guide student behavior and learning (The HLP Writing Team, 2017). HLPs are the foundation of good teaching for all disciplines. Secondary science educators should become familiar with HLPs and begin implementing practices, especially differentiation and modeling. To aid in this endeavor, Windschitl et

al. (2012) developed a set of four ambitious teaching practices specific to science based on HLPs.

Table 2.2 High Leverage Practices specific to science instruction

Ambitious Practices from Windschitl et al. (2012, p. 899)	Explanation	Corresponding HLP (TeachingWorks, 2020)
Selecting big ideas and treating them as models	The teacher should select a specific phenomenon which could be an event or a process so that students can try to make sense of it over time.	HLP 2. Explaining and modeling content, practices, and strategies.
Eliciting students' ideas and using them to adapt instruction	The teacher poses questions to students, listens to student talk, interprets student talk, and uses their interpretations to adapt instruction.	HLP 3. Eliciting and interpreting individual students' thinking.

Table 2.2 (Continued)

Ambitious Practices from Windschitl et al. (2012, p. 899)	Explanation	Corresponding HLP (TeachingWorks, 2020)
Choosing activity and framing intellectual work	The teacher showcases potential models and background knowledge as the basis for a lesson or a sequence of lessons.	HLP 14. Designing single lessons and sequences of lessons.
Pressing for explanation	The teacher expects students to be able to use evidence from inquiry or models to produce an explanation	HLP 15. Checking student understanding during and at the conclusion of lessons.

While these four practices are important, all 19 HLPs should be considered worthy of implementation by science teachers.

2.3.1.3 Evidence Based Practices

To ensure that one is effectively teaching students with learning disabilities in science, one must become familiar with the research. When reviewing the literature, teachers should seek evidence-based practices (EBPs), which are practices that are backed

by a substantial amount of quality research. Cook and Cook (2011) define evidence-based practices as, "practices that are supported by multiple, high-quality studies that utilize research designs from which causality can be inferred and that demonstrate meaningful effects on student outcomes," (p. 73). The Council for Exceptional Children (CEC) (2014) published a guide to evaluating research that included eight quality indicators for researchers to use when evaluating a body of literature around a practice as can be seen in Table 2.3.

Table 2.3 Research study quality indicators as described by the Council for Exceptional Children (2014)

	Description
1.	The study in question must provide specific details about the setting in which the study was conducted such as the grade level, type of school, type of classroom, and curriculum used.
2.	The population of the study must be clear. The study should provide descriptive information about the participants such as the type of disability, gender, age, and socioeconomic status. The study must also be clear on how the participants were identified as members of the target population.
3.	The study must fully describe the person or technology responsible for delivering the intervention.
4.	The study must fully describe the practice and any relevant materials and procedures.
5.	Implementation fidelity must be reported.

Table 2.3 (Continued)

	Description
6.	The study must exhibit sufficient internal validity. Study design and methods must be clear and of high quality.
7.	Outcome measures must be clearly described and must hold some significance to current practice (e.g. improved learning outcomes for students).
8.	The researchers performed an appropriate analysis of data and reported the required statistical measures.

To be classified as high quality, a study must meet all eight of the CEC's quality indicators. Often, teachers may find reviews that examine multiple studies on one practice to determine the effect size of that practice and whether there is substantial evidence that it positively influences student outcomes. When determining whether a practice is evidence-based, researchers are encouraged to only include high quality studies in their reviews (CEC, 2014).

It is important to note that although a practice may have a significant body of supporting literature, a single practice cannot be expected to meet the needs of all learners at once. Cook and Cook (2011) strongly encourage educators to continuously monitor students when implementing evidence-based practices to identify students who are not responding to the practice. A number of EBPs for teaching science to students with disabilities were found in the literature as shown in Table 2.4.

Table 2.4 Selected evidence-based strategies to use in inclusive secondary science classrooms

Practice	Citing Literature
Explicit Instruction	Scruggs et al., 2010
Mnemonics	Mastropieri & Scruggs, 2010; Scruggs & Mastropieri, 2000; Therrien et al., 2011; Wolgemuth, Cobb, & Alwell, 2008
Graphic Organizers and Study Aids	Dexter & Hughes, 2011; Scruggs et al., 2010
Inquiry-Based Instruction	Brigham et al., 2011; Therrien et al., 2011
Peer Tutoring	McDuffie, Mastropieri, & Scruggs, 2009; Scruggs et al., 2010; Stenhoff & Lignugaris/Kraft, 2007

2.3.1.3.1 MNEMONICS

One of the most common practices found in the literature was supplemental mnemonic instruction (Mastropieri & Scruggs, 2010; Scruggs & Mastropieri, 2000; Therrien et al., 2011; Wolgemuth, Cobb, & Alwell, 2008). There are three types of mnemonic instruction: keyword, pegword, and letter strategies. Keyword mnemonics are often picture based and use a keyword that is familiar to the student that can be associated with the new target word. An example of the keyword method in science is based on the word “ranidae” with the familiar keyword “rain.” As ranidae are common frogs, students

could be presented with a picture of a frog in the rain (rainy day = ranidae = frog) (Mastropieri & Scruggs, 2010). The pegword method relies on rhyming to help students remember ordered or numbered information. For example, the pegword for two is shoe, so to help students remember that a wheelbarrow is a second-class lever, students could be shown a picture of a wheelbarrow bumping into a shoe (Scruggs et al., 2007). Letter strategies are the most common and include the use of acronyms which contain letters to represent each word in the target information (Mastropieri & Scruggs, 2010). A well-known acronym in biology is PMAT (prophase, metaphase, anaphase, and telophase) to memorize the phases of mitosis.

Several literature reviews have examined the efficacy of mnemonics instruction in improving student learning outcomes. In a research synthesis of 34 experiments, Scruggs and Mastropieri (2000) found the overall effect size for mnemonics instruction was 1.62 which is considered a large effect size. Therrien et al. (2011) reviewed four studies on the effects of keyword, or keyword plus pegword mnemonic instruction on students' knowledge of science vocabulary and found that these strategies had a large effect size of 1.997. Unlike other reviews of mnemonics research, Wolgemuth et al. (2008) focused on using mnemonic strategies only at the secondary level. The researchers completed a systematic review of 20 studies focusing on using mnemonics with secondary level students with learning disabilities, emotional and behavioral disorders, and developmental disabilities. The researchers found the effect size of these strategies was 1.38, which is consistent with the large effect sizes reported in the other reviews (Wolgemuth et al., 2008).

Mnemonics instruction is one of the most well researched methods for including students with disabilities in general education science courses. Science teachers should

seek mnemonic devices for teaching students vocabulary and utilize them for students that might struggle. A limitation of supplemental mnemonics instruction is the relative lack of research on whether students retain the science vocabulary information long term. Several studies have shown that mnemonics help with short term vocabulary retention (Mastropieri & Scruggs, 2010; Scruggs & Mastropieri, 2000; Therrien et al., 2011; Wolgemuth, Cobb, & Alwell, 2008), but research is needed to determine if students retain the information long term.

2.3.1.3.2 Graphic Organizers and Study Aids

Graphic organizers and study aids such as study guides or advanced organizers have been shown to positively impact learning in students in special education. Within their review, Scruggs et al. (2007) calculated the mean effect size for both study aids and graphic organizers. Effect sizes were 0.94 and 0.93 respectively and were both considered large effect sizes. In a review of 14 articles on graphic organizers including four studies that took place in science classrooms, Dexter and Hughes (2011) determined that graphic organizers had a large effect size of 1.05 which indicates that they are useful in helping students learn science. They also calculated a large effect size of 0.80 for long term maintenance of science content knowledge when students used graphic organizers.

Study aids and graphic organizers align with the principles of UDL in that they give students multiple ways to process content and both can be used to aid in text processing. For example, if a science teacher needed students to read an article about a given concept, the teacher could provide students with a guide that helps them pick out and process the main ideas in the text. Science texts are often overloaded with advanced vocabulary and

organization that is unfamiliar to students with disabilities (Price et al., 2012). Providing organizers and study aids could help students make sense of difficult texts.

2.3.1.3.3 Inquiry-Based Instruction and Explicit Instruction

Therrien et al. (2011) determined that structured inquiry was an EBP in science with an effect size of 0.727 based on the results of the four included studies. It is important to note that research shows that structured inquiry is better for students with mild disabilities than open inquiry (Dalton et al., 1997) as open inquiry may be too overwhelming for students with special needs. Structured inquiry may be coupled with the practice of explicit instruction to better support students and diminish the overwhelming nature of open inquiry.

In a meta-analysis of studies on special education interventions, Scruggs et al. (2007) found that explicit instruction had the highest effect size (1.68) of all interventions in the 70 included studies. The use of explicit instruction in science includes breaking new information down into smaller chunks and allowing students time to practice or complete an activity after each chunk. Applied to inquiry learning, this becomes more like structured inquiry and is less daunting for students with disabilities. Explicit instruction lies within the principles of UDL and High Leverage Practices (HLP) (McLeskey, 2017; TeachingWorks, 2020) and all students in the classroom may benefit from the extra guidance. This teaching method also relies upon modeling the type of thinking teachers would like to see in their students which is another HLP. Students may become overwhelmed with the variety of approaches they are able to use in inquiry learning. Explicit instruction allows teachers to walk students through the thinking processes and activities required to complete an inquiry-based unit.

2.3.1.3.4 Peer Tutoring

Peer tutoring occurs when a student helps another student to learn and has been shown to be effective. Scruggs et al. (2007) calculated a mean effect size of 0.86 for peer mediation which included peer tutoring and groups of students engaging in debates. In a study comparing students from four seventh grade co-taught science classrooms with students in four traditional science classrooms, McDuffie et al. (2009) found that peer tutoring resulted in increased student achievement. Measures included scores on pre-tests and post-test on two state standards covering life sciences. Peer tutoring does not have to strictly consist of a high achieving student helping a low achieving student. In fact, the experimental design employed by McDuffie et al. (2009) saw students of similar ability paired together. Pairs of students took turns asking each other questions from a biology study guide. Peer tutors also practiced giving each other positive feedback. Science teachers can use peer tutoring to increase student engagement and content acquisition. Peer tutoring adheres to UDL guidelines by providing multiple means of accessing the material. Students can pair up to read difficult texts and discuss the content with each other which decreases barriers for students with disabilities in reading or communication.

2.3.1.3.5 Limitations of EBPs

According to the literature, the major hinderances to implementation of EBPs are that teachers find it difficult to identify EBPs, and that researchers claim that for EBPs to be effective, teachers must implement them exactly as designed (Russo-Campisi, 2017) which can be difficult when teachers are trained to make modifications for their students. Research is needed to explore the effects of modifications on the effectiveness of EBPs. Another significant hindrance is the lack of practitioner literature on EBPs specific to

science classrooms. Hott et al. (2018) conducted a review of practitioner journals in special education and found that of 3,245 journal articles published between 1988 and 2015 from five identified journals, only 29% of papers contained suggestions on how to implement researched interventions in classrooms for students with mild disabilities. Of those articles, the authors only identified nineteen papers that were related to instructional practices in science (Hott et al., 2018). The research to practice gap is a significant issue but seems to be especially significant for educators that teach science to students with disabilities. More research that is specific to science education is needed to establish EBPs, then those practices must be communicated to teachers through practitioner journals with examples of how to implement the practice.

A final limitation of the EBPs cited in this review is the age of the included papers. While the reviews of literature cited have been completed within the last decade, many of them were published before the CEC's guidelines were published. Updated reviews addressing the eight guidelines and whether the included studies meet those guidelines need to be conducted.

2.3.2 Co-Teaching to Increase Differentiation

Several articles focused on collaborative teaching as an excellent means to differentiate instruction (Brigham et al., 2011; Watt et al., 2013; Dieker & Rodriguez, 2013) Watt et at. (2013) proposed that the coteaching setting was a great environment for inquiry-based science education because coteaching pairs could provide an increased range of student supports. The work of Mastropieri, Scruggs, and Gretz (as cited in Brigham, Scruggs, & Mastropieri, 2011) provides evidence that collaborative teaching pairs that implemented differentiated instruction had students that outperformed students in co-

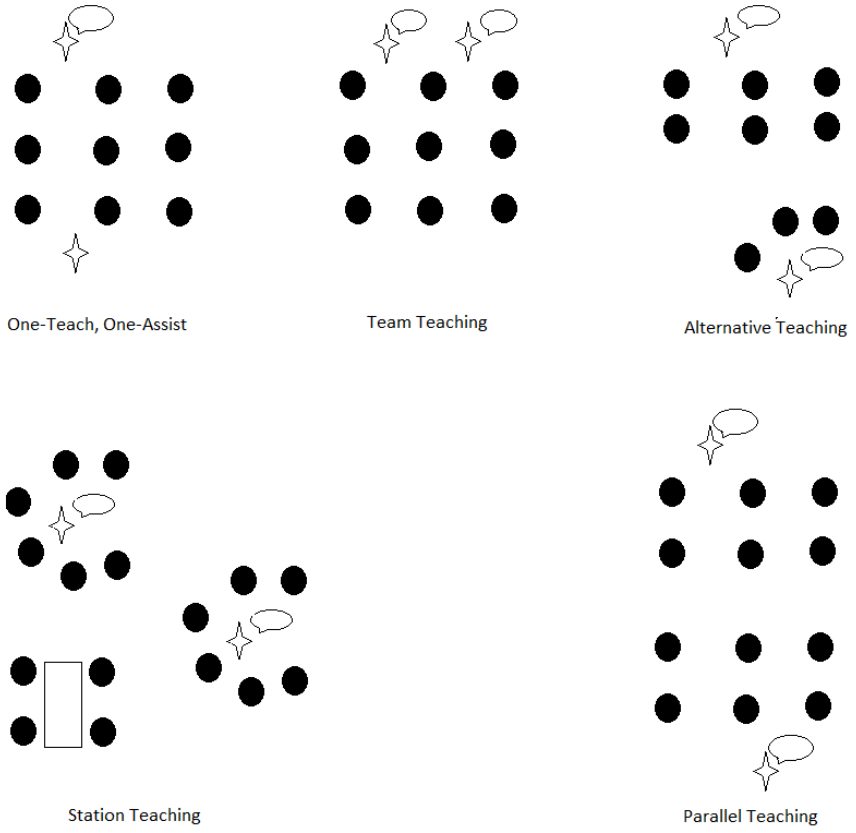
taught classrooms using traditional approaches. Dieker & Rodriguez (2013) discuss coteaching models and methods for implementing the models in science and mathematics classrooms. They state that collaborative teaching benefits students in that the two teachers together are better able to meet the needs of all learners through better differentiation, and that by having two teachers in the room, the teacher to student ratio is lowered which allows for more individualized help (Dieker & Rodriguez, 2013).

General education science teachers must ensure that their lessons are highly differentiated to provide the most inclusive environment for their students. However, science teachers may not be adequately trained for the appropriate accommodations for the different learning or behavioral disabilities they might encounter in their classrooms. By implementing collaborative teaching in secondary science courses, coteaching pairs could plan a curriculum and learning environment that would be effective and inclusive for every student.

2.4 Co-Teaching

Cook and Friend (1995) proposed that coteaching was a method to increase options for all students. They proposed that coteaching could also reduce the stigma associated with being in special education, increase teacher support, and increase the quality of curriculum and instruction. They outlined five models of coteaching, one teacher-one assistant, station teaching, parallel teaching, alternative teaching, and team teaching. These models can be seen in Figure 2.1.

Figure 2.1 Illustrations of Cook and Friend's (1995) five co-teaching models



One teach-one assist occurs when one of the teachers, usually the content teacher, leads the classroom while the other teacher acts as an assistant without providing instruction. Station teaching occurs when there are at least two different sections in the classroom. Each station will be led by one of the teachers or may be student-led. Moorehead & Grillo (2013) examined the benefits of station teaching in helping students learn content and meet their IEP goals. They also mention the benefits of a decreased teacher to student ratio and detailed methods for effective station teaching. They recommend splitting students into two or three groups and having each teacher work at a different station. They also recommend that teachers use station teaching to address IEP goals such as increasing literacy skills within the content (Moorehead & Grillo, 2013).

Students will rotate through the different stations until each student has received all the content from each station. Parallel teaching occurs when the class is divided into two groups with one teacher each, which lowers the teacher to student ratio. Both groups receive the same instruction in about the same amount of time. Alternative teaching refers to the practice of having one of the teachers pull a small group of students for specialized instruction while the other teacher continues with regular instruction. This allows for pre-teaching or re-teaching for the students that really need it. Team teaching occurs when both teachers lead the discussion or lecture. The teachers share equal responsibility and take turns teaching portions of the same lecture (Cook & Friend, 1995).

Relying heavily on the work of Cook and Friend (1995), Gately and Gately, Jr. (2001) discuss how learning to coteach is based on a continuum or a developmental process in which co-teachers are first guarded in their interactions, then they progress to a stage of compromising, then finally to a mutually beneficial collaboration. The authors describe eight components of successful co-teaching which include interpersonal communication, physical arrangement, familiarity with curriculum, curriculum goals and modifications, planning, presentation, classroom management, and assessment. They explain that for a partnership to be successful, co-teachers much co-plan lessons and assessment, structure the physical space in the classroom to be inclusive, communicate with each other freely, share classroom management responsibilities, and present material together. The special educator is expected to become familiar with the science content while the general educator is expected to become familiar with disabilities and accommodations. They present two versions of a coteaching rating scale based on the eight components of successful co-teaching that include questions from the perspective of a general educator and the

perspective of the special educator. They intend for teaching pairs to use the rating scales to identify areas of their practice that need improvement so that they can work together to set goals related to becoming better partners (Gately & Gately, Jr., 2001).

Like Gately and Gately, Jr. (2001), Ploessl et al. (2010) argue that open communication, reflection on coteaching practices, and planning instruction together are essential to a successful co-teaching partnership. The authors point out that cultural differences may exist between co-teaching partners and communication is key to avoiding potential arguments or disagreements. They state that planning and preparation are essential and co-teachers should implement a planning guide with meeting protocols and timelines for instruction so that pairs can stay on track (Ploessl et al., 2010).

2.4.1 Implementation and Recommendations

Many of the identified articles discussed proper implementation of co-teaching (Scruggs et al. 2007; Hines, 2008) and recommendations for using planning time to increase implementation of co-teaching in science classrooms (Fenty et al., 2013; Simon 2018).

2.4.1.1 Proper Implementation

In their meta-synthesis of thirty-two papers related to coteaching, Scruggs et al. (2007) found five major themes within the literature: collaboration between students, positive teacher perceptions of co-teaching, the need for administrative supports, the fact that one-teach, one-assist is the most common co-teaching model, and the notion that the special education teacher is just a helper. The authors stated that teachers sometimes noticed more collaboration between students in co-taught classes and that teachers needed administrative support to foster skills such as co-planning (Scruggs et al., 2007). Hines

(2008) also argued that principals play an important role in the success of co-teaching. The author states that in order for collaboration to be effective, the principal must instill in coteaching teams the belief that both the special education and regular education teachers are equal leaders in the classroom. The principal is responsible for facilitating effective collaborative teaching to operate a truly inclusive program. Other important duties for the principal include providing positive sharing activities, scheduling time for planning, having teachers document teaming activities, visiting functioning inclusive settings, providing good resources, and celebrating all successes. Regarding planning time, the author states its importance and provides the example of one district actually paying for substitute teachers so that coteaching teams can plan together.

2.4.1.2 Planning Time

As noted in Scruggs et al. (2007) and Hines (2008), planning time was a common theme in the literature (Fenty et al., 2013; Simon 2018). Simon (2018) conducted a case study in which five pairs of co-teachers in urban New York were interviewed and observed to determine how the teachers defined successful coteaching. Teacher beliefs focused on the need for common planning time, attitudes toward co-teaching, and training. Findings indicated that teachers perceived common planning time and adequate training in coteaching to be essential for success in collaboration. Teachers also expressed the opinion that a positive attitude toward coteaching led to increased success (Simon, 2018). Fenty et al., (2012) emphasized the importance of planning with the co-teaching team. They list the steps as building the collaborative team, organizing instruction and establishing teaching roles, and organizing all the required materials (Fenty et al., 2012).

2.4.2 Co-Teaching in Science

Secondary science teachers may not have an adequate amount of training for working with students with mild disabilities and may find it difficult or overwhelming to provide the necessary amount of support and differentiation that is required to teach in an inclusive classroom. Co-teaching can increase access to differentiation strategies such as mnemonic devices, graphic organizers, and study aids. Studies have shown that while opinions on co-teaching are generally positive, co-teachers are not fully implementing recommended strategies and may feel like they need further support (King-Sears et al., 2014; Scruggs et al., 2007). Research also shows that co-teaching can have positive impacts on student learning in science, though further research is needed in this area (Therrien et al., 2011; Thornton et al., 2015; Watt et al., 2013).

In a case study of one co-taught secondary science classroom, King-Sears et al. (2014)

surveyed a secondary science teacher, the special education co-teaching partner, and the pairs' students. Similar to other studies that show one-teach, one-assist is the primary co-teaching model (Scruggs et al., 2007), the researchers found that the science content teacher is the primary leader in the classroom and presented new content three times as often as the special education teacher. In spite of the lack of content presentation by the special educatory, students still seemed to view the special education teacher as an authority in the classroom. Student surveys indicated that 43% of students viewed the science teacher as the lead teacher, 14% percent viewed the special educator as the lead teacher, and 43% percent of students saw both teachers as in charge of lessons (King-Sears et al., 2014).

Dieker and Rodriguez (2013) argued for the possible benefits of effective co-teaching in math and science at the secondary level. They propose that both general and special education teachers had specialized knowledge and could learn from each other (Dieker & Rodriguez, 2013). However, they found that the coteaching model used most often was one teach-one assist which treats the special education teacher as an assistant instead of an equal. They claim that this model is more common due to the special education teacher's lack of content knowledge. They propose that the best example of collaborative teaching, team teaching, occurs when the special education teacher acts as an equal and elevates the students' experiences by differentiating or modifying the material, making sure students understand specialized vocabulary, and by being able to work with groups of students one on one (Dieker & Rodriguez, 2013). The researchers have provided a sound argument for the benefits of collaborative teaching and have provided examples of how collaborative teaching can be implemented in science. However, they do not tackle many of the issues working against successful implementation such as lack of district funding for an adequate number of special education teachers, lack of administrative support, and a lack of training to help teaching pairs to be successful.

2.4.3 Barriers to Implementation in Science

Linz et al. (2008) say their co-teaching team was created after their two previous teams had failed due to personality and experience clashes by the two teachers. They make the important point that personalities and experiences should be considered when administrators choose collaborative teams. Department heads, teachers, and principals should work together to assess both general and special education teachers' personality traits to assign the best teams. The authors state that it is crucial to have the students see

both teachers as equal authorities instead of one teacher and one assistant. They also mention that the two teachers should collaborate to develop a syllabus that sets a realistic pace for an inclusive classroom and discuss modifications for assignments. They say that the key point of working together before the school year starts is to develop trust within the collaborative team. Linz et al. (2008) outlined the struggles both teachers faced when implementing coteaching. The science teacher faced issues including sharing ownership of content delivery, learning how to work with students with disabilities, and learning to differentiate or vary their teaching style. The special education teacher stated that the first year of teaming should be focused on having the special education teacher learn the content. She suggests having the teacher do the labs and homework, staying a step ahead of the student so that she can still run the study sessions and help the students. She says the second year, when the special education teacher is comfortable with the content, she can begin to deliver the material. The authors encourage each teacher to learn about the skills of the other. The science teacher is encouraged to learn about the IEP process, attend professional development on collaborative teaching, and observe successful collaborative teams. Special education teachers are encouraged to make efforts to engage in and learn the science content such as joining NSTA or taking a college science course (Linz et al., 2008).

2.4.4 Gaps Within the Literature and Study Significance

A major limitation of research in this area is the lack of quantitative studies examining co-teaching. Few studies examine the effectiveness of co-teaching on improving student learning outcomes. Murawski and Swanson (2001) completed a meta-analysis of six quantitative studies on co-teaching to determine whether co-teaching has a

positive effect on student outcomes. They found that co-teaching had a moderate effect size of 0.40, but caution that only three of the included studies contained effect sizes that were related to students with disabilities. It has been noted that the quantitative studies that have been done should be interpreted with caution as they often do not meet the eight quality indicators set forth by the CEC. As stated in Weiss and Rogers (2020) many of the studies on co-teaching find it difficult to establish causality as they cannot separate the effects of co-teaching from other variables in the study such as student disabilities or teacher attributes. They also noted that many studies have not adequately described methods for measuring co-teaching success. High quality quantitative studies that examine the effects of co-teaching on student learning outcomes are needed.

Few articles presented empirical data relating to the effectiveness of co-teaching in improving student outcomes. The most notable example is the work of Thornton et al. (2015). The researchers set out to determine whether collaborative pre-teaching, or the practice of pulling a small group of students for individualized instruction before implementing a whole group lesson, could affect the achievement scores of two students with specific learning disabilities. Using a pre/posttest model with a state-mandated biology curriculum, the researchers found that coteaching, particularly coteaching done before a lesson to provide a student with learning disabilities an opportunity to learn key vocabulary and facts before a lesson, has been shown to increase student success during a lesson in the general education setting. Both participants showed improvements on daily biology tests (Thornton et al., 2015).

Research is needed to ascertain the level at which secondary science teachers are practicing coteaching with a special educator in classrooms containing students of mixed

ability levels. Many articles were located that contained detailed descriptions of what successful coteaching entails but very few were found that had any sort of empirical data relating to the implementation of co-teaching in science classrooms. Research is also needed to uncover whether co-teaching is actually beneficial to student learning in science classrooms. A possible benefit is an increase in differentiation within science lessons which could lead to better learning outcomes. Science teachers may improve their differentiation skills by working with a special educator. While this study will not measure student learning outcomes or levels of differentiation, participants will be asked to describe how they believe coteaching impacts their students and their teaching practices. Further, while located articles did provide some insight on the barriers to successful implementation of coteaching, practical solutions were not often discussed. This research seeks to gain the teachers' perspective on barriers to implementation and possible solutions to the challenges they face when it comes to planning lessons and carrying out coteaching.

Teaching students with special needs in secondary biology classrooms or secondary science classrooms in general can be challenging for science teachers. Science teachers may not feel adequately prepared to teach in a fully inclusive manner. Studies have shown teacher preparation programs and professional development opportunities may be lacking when it comes to training secondary science teachers to teach students with special needs (Kahn & Lewis, 2014; Mumba et al., 2015). Research has also shown that while science teachers are attempting to differentiate instruction to be more inclusive of students with disabilities, the types or levels of differentiation may be inadequate to meet the needs of all learners (Maeng & Bell, 2015; Riedell, 2017).

Several strategies for teaching science to students with disabilities were located within the literature including principles from Universal Design for Learning, High Leverage Practices, evidence-based practices, and co-teaching with a special education teacher. Teachers must become familiar with evidence-based practices such as supplementary mnemonics, structured inquiry, graphic organizers, study aids, peer tutoring, and explicit instruction as these strategies have been shown to be effective for improving student learning outcomes in science (Dexter & Hughes, 2011; McDuffie, Mastropieri, & Scruggs, 2009; Mastropieri & Scruggs, 2010; Scruggs & Mastropieri, 2000; Scruggs et al., 2007; Therrien et al., 2011; Wolgemuth, Cobb, & Alwell, 2008).

Limitations include the relatively small amount of literature related to students with disabilities in science, particularly secondary science. While studies on teaching science to students with disabilities were located, many of them focused on middle level classrooms or a combination of K-12 grade levels while few focused on secondary science or courses such as biology and chemistry. Research is needed to fully establish evidence-based practices in secondary science. Another limitation of research in this area is the dearth of practitioner articles communicating research to science teachers. As stated by Hott et al. (2018), only 19 articles from five practitioner journals in special education over nearly three decades communicated information about teaching science to students with disabilities. Research specific to secondary science instruction for students with disabilities is needed and must be communicated via practitioner articles so that teachers can begin implementing evidence-based strategies in their classrooms.

Co-teaching with a special education teacher was also proposed as a method for improving learning outcomes for students in special education in secondary science. There

are many practitioner articles that detail how to implement co-teaching in science classrooms (Dieker & Rodriguez, 2013; Linz et al., 2008; Moorehead & Grillo, 2013). These articles advocate for strategies such as co-planning, team teaching, and station teaching. However, research to measure the extent to which science co-teaching teams are implementing these recommendations has not yet been completed. This study seeks to establish a baseline for how well and to what extent science co-teaching teams are implementing the recommended strategies for co-teaching. After understanding co-teaching implementation in science classrooms, studies can then be completed to explore how proper co-teaching impacts student learning outcomes.

2.5 Instruments

2.5.1 The Co-Teacher Relationship Scale

The Co-Teacher Relationship Scale (CRS) (Noonan et al., 2003) was designed to generate measures of quality related to co-teacher relationships (See Appendix A). The authors compiled a list of thirty-nine traits and characteristics from the literature that described successful co-teaching partnerships including items such as personality traits, teacher characteristics, and approaches to teaching. After conducting a factor analysis on pilot study data, only one substantial factor with nineteen items was found and retained for the study. The 20 items related to personality traits of participants were eliminated from the instrument. The final CRS contains two sections. The first section contains 10 items that focus on teacher beliefs and approaches to teaching. The second section, consisting of 9 questions, focuses on the extent to which one partner believes they are similar to their co-teaching partners. The researchers conducted a study on the reliability and validity of

the tool with twenty co-teachers in early childhood education in Hawaii. Internal reliability (Cronbach's alpha) was found to be 0.90 (Noonan et al., 2003).

Cramer and Nevin (2006) tested the CRS within Miami-Dade Public Schools in Florida with 46 co-teachers from five high schools, one middle school, two alternative schools, and fourteen elementary schools. Although the researchers mention math and science co-teachers, exact numbers of teams in each content area were not listed. Results of this study indicated that the highest rated items were "interest in learning new things" (mean = 4.46), "dedication to teaching" (mean = 4.44), and "ability to be supportive to colleagues and other staff" (mean = 4.25). The researchers collected demographic information such as the number of years of teaching experience and conducted an analysis of variance (ANOVA) statistical test. They found that there was a significant difference ($p<0.05$) between years of experience and teacher confidence in that teachers that reported more years of experience also reported higher co-teaching confidence. The researchers concluded that the CRS had been validated since their sample was culturally and linguistically diverse from the sample in the original study. They stated that the CRS was likely generalizable to other populations, though they encouraged further research (Cramer & Nevin, 2006).

To build on the two previous studies and test the CRS in Arizona, Malian and McRae (2010) conducted a study to determine if there was a relationship between the responses of special educators and general educators on the CRS. The survey participants included 290 co-teachers from 9 junior high schools, 160 elementary schools, 70 middle schools, and 50 high schools across Arizona. Unlike Cramer and Nevin (2006), the researchers did not observe any statistically significant differences in the responses of special educators and

general educators on any of the items or overall. They propose that this may be due to "a positive mutual attitudinal shift towards collaboration between general and special educators," (Malian & McRae, 2010, p.13).

2.5.2 Are We Really Co-Teachers Rating Scale

The Are We Really Co-Teachers? Rating Scale (AWRCT) developed by Villa et al. (2004) was formed based on existing co-teaching literature. The original scale format contains thirty-four questions about whether the teacher is implementing a co-teaching practice which are answered by simply checking yes or no (See Appendix B). The authors intended for co-teachers to use the scale as a reflection tool so that they could identify strengths and weaknesses and set goals for improvement. Examples of items include "We share ideas, information, and materials", and "We share responsibility for deciding who teaches which part of a lesson" (Villa et al., 2013, pp. 380-382). Lava (2012) used the survey in its original form in a small case study of one new (less than a year of experience in co-teaching) fourth grade co-teaching team. The two participants reported agreement on 31/34 items. The researcher states that the most noticeable disagreement was on the item that dealt with including other professionals when their expertise is needed. The general education teacher believed they should reach out to the science instructional coach more often, but the special education teacher believed they were already adequately including other professionals. In this study, the AWRCT was used to measure the health of the participants' partnership. The researcher report that with the high level of agreement between the two teachers, the partnership was healthy (Lava, 2012).

Instead of using the scale in its original yes or no format, other studies have used the instrument as a five-point Likert scale (Cramer & Nevin, 2006; Haimowitz, 2018; Ricci et

al., 2019). Haimowitz (2018) used the scale 1 (never) to 5 (always) with the survey items, while the two other studies used the scale 1 (less than once a week) to 5 (daily actions of co-teachers).

Haimowitz' (2018) study used two surveys and interviews to determine whether teacher attitudes toward the practice of co-teaching affected the implementation of co-teaching. Participants for the surveys included 41 general education teachers and 10 special education teachers from across K-12 grade levels in one school district. The AWRCT was used to measure the amount of co-teaching occurring in the participants' classrooms. To get an implementation score, the sum of scores from each item was found. The researchers found that the average implementation score of teachers with more than ten years of experience was 117.67 out of a possible 155, while the average score for teachers with less than ten years of experience was 115.92. There was no significant difference between the two groups. The researchers stated that "there was a cause and effect relationship between the attitudes and implementation for teachers with 10 or more years of experience" (Haimowitz, 2018, p. 100). No other significant relationships were reported.

Cramer and Nevin (2006) used the survey in addition to the CRS and found that when used together, the CRS and the AWRCT "may have some merit in explaining co-teacher relationships and actions. The validation from interviews and observations strengthens the believability of the assessment scales in differentiating co-teacher beliefs, attitudes, and actions" (Cramer & Nevin, 2006, p. 270). The highest rated items on the AWRCT were related to giving each other feedback (mean = 4.40) and being flexible during lessons (mean = 4.41). Like Haimowitz (2018), the researchers reported no statistically significant relationships between years of teaching and the survey items (Cramer & Nevin, 2006).

Unlike these two studies, this proposed study aims to examine relationships based on years co-teaching with the same co-teacher instead of overall teaching experience or overall co-teaching experience.

The survey has also been used to evaluate co-teaching in other contexts. Ricci et al. (2019) use the AWRCT scale to evaluate the implementation of co-teaching between pre-service secondary math and science teachers and their in-service mentor teachers. The program under study was part of a year long urban teacher residency program with 20 general education pre-service teachers. The researcher calculated Cronbach's alpha as 0.97 in this study. Results indicated that the most common behavior was both teachers being viewed by the students as their teacher. The teachers believed this happened on average more than four times per week. Similar to results from Cramer and Nevin (2006), the other most common behavior was being flexible during lessons with over half of the participants reporting that this happened daily. The authors state that these findings suggest this is a viable method of training future general educators to co-teach with a special educator in their own classrooms (Ricci et al., 2019).

While useful for teachers' personal reflection in its original format, other researchers have adapted the questionnaire into a Likert scale format for a more detailed quantitative analysis (Cramer & Nevin, 2006; Haimowitz, 2018; Ricci et al., 2019). As it was the only study to report internal reliability, the scale used in Ricci et al. (2019) will be in this study. Responses will range from 1 (less than once a week) to 5 (daily actions). This survey has thirty-four questions related to actions of co-teaching pairs and asks participants to indicate how often they engage in each action.

CHAPTER 3. METHODOLOGY

3.1 Introduction and Research Questions

The purpose of this study is to understand the extent to which secondary science co-teachers are implementing co-teaching techniques and strategies for successful co-teaching. This study will provide an understanding of co-teachers' implementation of co-teaching in science, implementation levels of recommended co-teaching techniques, the perceived barriers to proper implementation of co-teaching, and teacher generated solutions to problems with co-teaching in science. Using the baseline for implementation of co-teaching established in this study, future research projects may explore topics such as professional development programs to train co-teachers and the effect of co-teaching on student achievement in classrooms with effective co-teaching practices.

The following research questions were developed to guide the study:

1. How do teachers perceive the co-teaching relationships and implementation of co-teaching in their classrooms? How do general and special educators' perceptions of co-teaching differ?
2. To what extent are secondary science teachers practicing co-teaching with a special education teacher in their classrooms?
3. How do teachers' perceptions of their co-teaching relationships affect the implementation of co-teaching?

To examine these questions, a mixed methods study using surveys and one-on-one interviews was implemented.

Table 3.1 Overview of the Data Sources for the Research Questions

Research Questions	Data Sources
How do teachers perceive the co-teaching relationships and implementation of co-teaching in their classrooms? How do general and special educators' perceptions of co-teaching differ?	The Co-Teacher Relationship Scale (Noonan et al., 2003); Are We Really Co-Teaching Rating Scale (Villa et al., 2013); Interviews
To what extent are secondary science teachers practicing co-teaching with a special education teacher in their classrooms?	Are We Really Co-Teaching Rating Scale (Villa et al., 2013); Interviews
How do teachers' perceptions of their co-teaching relationships affect the implementation of co-teaching?	The Co-Teacher Relationship Scale (Noonan et al., 2003); Are We Really Co-Teaching Rating Scale (Villa et al., 2013); Interviews

3.2 Rationale

An explanatory sequential design (Creswell, 2012) was chosen for this study because the qualitative interview data will further explain the quantitative data collected in Phase 1 of the study. The explanatory sequential design is a form of mixed methods research that employs an initial round of quantitative data collection and analysis followed by a round of qualitative data collection that is used to explain quantitative results (Creswell, 2012). Phase 1 of this study consisted of two surveys that will measure co-teaching attitudes, relationships, and implementation of co-teaching practices (Noonan et al.,2003; Villa et al., 2013). Quantitative data will be analyzed for trends in current co-teaching practices and any abnormally high or low scores on the instruments will be noted. After the quantitative data has been collected and analyzed, the interview protocol will be refined, and one-on-one interviews will be conducted with teachers. The qualitative data from these interviews will be used to explain or understand the quantitative data.

3.3 Participants and Sampling

To sample the entire state of Kentucky, similar sampling procedures as outlined in Ackerman (2017) were followed. Kentucky contains nine educational cooperatives comprised of 172 school districts (Kentucky Department of Education, 2020). Lists of school districts were obtained from their respective cooperatives. From this list, each high school in each district was added to a spreadsheet. To obtain a simple random sample, a random number generator was used to select half of the high schools in each cooperative. These schools formed the sampling frame (N=106). Email addresses for secondary science general education teachers and special education teachers were obtained via publicly

available school directories. If teacher email addresses were not readily available, principals were emailed (N=52) and asked to forward the invitation email to their science teachers and special education teachers.

The teachers were contacted via email (N=449) to be recruited for the surveys. The email informed teachers that by responding to the survey, they would be entered into a drawing to win one of four $25 Visa gift cards. The initial recruiting emails were sent during the third week of March 2021. Approximately two weeks after the original email, a reminder email was sent to non-responding teachers and all principals. Approximately two weeks later, a final reminder email was sent to all non-responding teachers. Although the recruitment email was sent to all secondary science and special education teachers, only teachers who identified themselves as science co-teachers were able to complete the survey. Question 1 of the survey asks, "Do you consider yourself a co-teacher in a secondary level science classroom?" If the participant selected no, they were taken to the end of the survey instead of answering the survey questions. The final questions asked participants if they were willing to further participate in classroom observations and interviews. The survey was closed, and principals and superintendents were sent emails to ask for permission to interview teachers that had opted in to participating in interviews during the last week of April 2021. Interviews were scheduled and completed during the first and second weeks of June 2021. Demographic information such as the number of years teaching science, number of years co-teaching, and number of years co-teaching with their current partner were obtained and reported using descriptive statistics.

3.4 Instruments

To save time for the participants and to make data collection manageable, the following two surveys were combined (See Appendix C) so that teachers would only be given one Qualtrics link.

3.4.1 The Co-Teacher Relationship Scale

As the previous study by Cramer and Nevin (2006) treated the data and scale from this instrument as interval data, this study will also analyze the scale data as interval data. This means that the distance between each number on the scale is equal, otherwise it would have to be treated as an ordinal scale. The software SPSS will be used to calculate descriptive statistics including the mean and standard deviation for each of the 19 items. An overall score will also be calculated by finding the sum of ratings on all 19 nineteen items, with a maximum score of 95. Data will be treated as non-parametric in all cases, as it has been cautioned small sample sizes often lead to non-normal distributions as they are not good estimates of a larger population (Krithikadatta, 2014). It has also been noted that it is difficult to achieve a significant Shapiro-Wilk result for small sample sizes when testing for normality as deviations from a normal distribution must be very large (Mann-Whitney Tests in SPSS, n.d.). The Mann-Whitney U Test will be performed on the data to examine whether there is a difference in scores between general educators and special educators.

To examine whether the years spent teaching together as part of a co-teaching team influence relationship scores, responses to demographics will be broken down into groups such as new teams (0-1 year together), familiar teams (2-4 years together), and experienced

teams (5 or more years together). As there will be more than two groups, analysis will consist of a Kruskal Wallis H test to determine if there are significant differences between the experience groups and a post hoc test with pairwise comparisons will determine which groups significantly differ (Lewis-Beck & Lewis-Beck, 2015).

3.4.2 Are We Really Co-Teachers Rating Scale

While useful for teachers' personal reflection in its original format, other researchers have adapted the questionnaire into a Likert scale format for a more detailed quantitative analysis (Cramer & Nevin, 2006; Haimowitz, 2018; Ricci et al., 2019). As it was the only study to report internal reliability, the scale used in Ricci et al. (2019) will be used in this study. This survey has thirty-four questions related to actions of co-teaching pairs and asks participants to indicate how often they engage in each action. Responses will range from 1 (less than once a week) to 5 (daily actions).

The mean for each question and the average overall score on the instrument will determine the extent to which science educators are practicing co-teaching. Statistical differences between science teachers' and special education teachers' mean responses will also be examined using a Mann-Whitney U test. Like the analysis of the CRS data, this survey will be analyzed by running an Kruskal-Wallis H test with a pairwise post-hoc test to determine if there are differences based on years of experience co-teaching with the same partner.

3.4.3 Implementation Scores and Co-Teaching Relationships

To examine the third research question, linear regression (Lewis-Beck & Lewis-Beck, 2015) will be used to test the hypothesis that there is a relationship between

implementation scores from the AWRCT survey and relationship scores from the CRS. Previous research has demonstrated that the two surveys are able to work together to explain co-teacher relationships and actions (Cramer & Nevin, 2006).

The model will be run as follows:

$$\widehat{AWRCT\ Score} = \widehat{\beta_0} + \widehat{\beta_1} CRS\ Score$$

The model will be used to test the null hypothesis "Teacher perception of their relationship with their co-teacher as reported on the CRS has no effect on teacher perception of implementation of co-teaching as reported on the AWRCT." Appropriate correlation statistics such as Pearson's R and r^2 will be reported and used to determine significance.

3.5 Interviews

Seidman (2006) recommends a three-interview structure so that participants have time to reflect upon their answers and experiences. However, time constraints and participants' schedules did not allow for three separate interviews. Seidman (2006) provides an example of conducting all three interviews in one day which was the format chosen for this study. Questions were divided into three themes or sets. Question set one focuses on the teaching history and demographics of each participant. Questions include topics such as what brought the teacher to this school, years of experience in co-teaching, and their content area. Set two focuses on the participants' current and prior co-teaching practices. The final set focuses on having the participants reflect on their practices. This section of the interview asks teachers about challenges in implementation and possible solutions to these challenges. The interviews followed a semi-structured format in that a protocol was developed (See Appendix D) , but the interview was fluid, and questions were

adapted to the participant (Merriam, 1998). Interview questions were added or refined to help explain the quantitative data collected from the questionnaires and observations.

The final set of questions on the survey asked participants if they were willing to participate in a one-on-one interview with the researcher. If the participant selected yes, permission was obtained from either their principal or superintendent before the interview was scheduled. The interviews were completed via the Zoom online meeting platform and were recorded so that they could be transcribed for analysis of major themes. Interviews took approximately thirty minutes each. An inductive approach to coding was taken in this study. Following the procedures outlined in Bogdan and Biklen (2007), interview responses were analyzed to determine patterns and to come up with a coding scheme. After interviews were transcribed, they were carefully read to pull out major themes in the responses. Themes that added meaning to survey responses and themes that appeared in all interview transcripts were adopted as codes. While coding, the idea of asides and commentary from Emerson et. al (2011) was used to make notes on the participant's demeanor and to add context to responses.

As the quantitative data obtained from the questionnaires did not fully capture or explain the extent to which co-teaching is practiced in secondary science classrooms, the qualitative interviews were used to clarify and explain the quantitative results. For example, questionnaire results may have indicated that teachers are not implementing co-planning and interviews would have been used to understand why. The data was expected to work together to fully explain how co-teaching is implemented in secondary science classes.

CHAPTER 4. RESULTS

4.1 Participants

The response rate for the survey was approximately 10.9% (*N*=49) when calculated using the emails that were sent directly to the teachers. It is unknown how many teachers were contacted by principals. Of those responses, 23 were screened out by Question 1, 5 more participants quit before beginning the survey, 2 more stopped before completing the first portion of the survey, 1 response was a duplicate, and 1 participant finished the survey but indicated that they were not actually a co-teacher. In total, 17 usable responses were collected (3.79% of the 449 teachers who were contacted).

Table 4.1 Number of Participants from Each Educational Cooperative

Educational Cooperative	Number of Participants (*N)*
Green River Regional Educational Cooperative	10
Ohio Valley Educational Cooperative	2
Southeast/Southcentral Education Cooperative	2
Central Kentucky Educational Cooperative	2
Kentucky Educational Development Corporation	1

Participants represented five of the nine educational cooperatives, with the majority of participants working in the Green River Regional Educational Cooperative. No teachers from the Jefferson County Exceptional Child Education Services, Kentucky Valley,

Northern Kentucky, or West Kentucky education cooperatives elected to participate in this study.

Table 4.2 Participant Demographics

	Year of Teaching Experience			Years of Co-Teaching Experience			Years with Current Co-Teacher		
Teacher Type	0-1	2-4	5 or more	0-1	2-4	5 or more	0-1	2-4	5 or more
Science (*N*=12)	1	0	11	1	3	8	6	5	1
Special Education (*N*=5)	0	0	5	0	2	3	1	3	1

Twelve participants were science teachers, and five participants were special education teachers. Three of the science teachers only completed the Co-Teacher Relationship Scale (they exited the survey before completing the Are We Really Co-Teaching Rating Scale), while all special education teachers completed both portions of the survey.

Table 4.3 Interview Participant Demographics and Scores

	Specialty	HS	Years of Experience	Years of Co-Teaching	Total Score CRS	Total Score AWRCT
Denise	Science/Biology	Tulip	5+	6	88	104
Martin	Science/ Chemistry and Physics	Poppy	5+	10	74	106
Gordon	SPED/ Science and Math	Daisy	5+	14	68	92

All interview participants were from the Green River Educational Cooperative.

Table 4.4 K-PREP Scores from the 2018-2019 School Year in Interview Participants' Schools Comparing Scores from Students with an IEP (SWD) to Scores from Students with No Identified Disabilities (SND)

		N	A	P	D	P+D
Tulip High School	SWD (*N*=12)	33.3	58.3	0.0	8.3	8.3
	SND (*N*=118)	11.9	49.2	37.3	1.7	39.0
Poppy High School	SWD (*N*=32)	18.8	81.3	0.0	0.0	0.0
	SND (*N*=233)	12.4	54.1	31.8	1.7	33.5
Daisy High School	SWD (*N*=4)	Data Unavailable				
	SND (*N*=68)					
	All Students (Daisy) (*N*=72)	11.1	45.8	38.9	4.2	43.1

Note. N = Novice, A = Apprentice, P = Proficient, D = Distinguished, and P + D = Proficient and Distinguished.

None of the students at Daisy High School were tested on alternate standards. Most of the data from this high school was suppressed either due to FERPA or due to having less than

10 students. One student at Tulip High School and two students at Poppy High School were tested on alternate standards but the data for these students was suppressed (Kentucky Department of Education, 2019).

4.2 Research Question 1

The Co-Teacher Relationship Scale and interviews were used to explore research question 1:

> How do teachers perceive the co-teaching relationships and implementation of co-teaching in their classrooms? How do general and special educators' perceptions of co-teaching differ?

The following sections will be used to organize and present the data from these sources.

4.2.1 Co-Teacher Relationship Scale

The participants' responses to the CRS provide evidence for their perception of their co-teaching relationships within their science classrooms. Table 4.5 shows the means and standard deviations for the teachers' answers on each question of the CRS. The CRS asks teachers to "Indicate the extent to which you believe you and your co-teacher are the same or different in your beliefs and approaches to teaching, and personal/professional characteristics and style," with the scale ranging from 1 (very different) to 5 (very similar) (Noonan et al., 2003). A copy of the CRS with full text of the questions may be found in Appendix A.

Table 4.5 Means and Standard Deviations for Answers on the Co-Teacher Relationship Scale. The Scale Ranges From 1 (Very Different) to 5 (Very Similar).

	Overall Mean *N*=17	Science Teachers *N*=12	Special Education Teachers *N*=5
Total CRS Score	78.76 (11.20)	79.75 (12.11)	76.40 (9.40)
Q1	4.18 (0.73)	4.17 (0.83)	4.20 (0.45)
Q2	3.88 (0.86)	4.00 (0.85)	3.60 (0.89)
Q3	3.71 (0.77)	3.75 (0.75)	3.60 (0.89)
Q4	4.12 (0.78)	4.25 (0.87)	3.80 (0.45)
Q5	3.82 (1.13)	3.92 (1.16)	3.60 (1.14)
Q6	4.47 (0.72)	4.67 (0.65)	4.00 (0.71)
Q7	4.06 (1.09)	4.17 (1.03)	3.80 (1.30)
Q8	3.94 (1.25)	4.08 (1.16)	3.60 (1.52)
Q9	4.12 (1.17)	4.25 (1.22)	3.80 (1.10)
Q10	4.47 (0.87)	4.58 (0.90)	4.20 (0.84)

Table 4.5 (Continued)

	Overall Mean *N*=17	Science Teachers *N*=12	Special Education Teachers *N*=5
Q11	4.35 (0.86)	4.50 (0.90)	4.00 (0.71)
Q12	4.19 (0.91)	4.27 (1.01)	4.00 (0.71)
Q13	3.82 (0.95)	3.67 (1.07)	4.20 (0.45)
Q14	3.76 (1.20)	3.58 (1.38)	4.20 (0.45)
Q15	4.18 (1.07)	4.08 (1.24)	4.40 (0.55)
Q16	4.29 (0.92)	4.33 (0.98)	4.20 (0.84)
Q17	4.65 (0.61)	4.75 (0.45)	4.40 (0.89)
Q18	4.29 (0.99)	4.33 (1.07)	4.20 (0.84)
Q19	4.71 (0.47)	4.75 (0.45)	4.60 (0.55)

Question 3, “Views regarding how to structure students' activities,” had the lowest average score of all items (All participants: M=3.71, SD=0.77; Science Teachers: M=3.75, SD=0.75; Special Education Teachers: M=3.60, SD=0.89). The question with the highest

average score was question 19, “Dedication to teaching,”(All participants: M=4.71 , SD=0.47; Science teachers: M=4.75, SD=0.45; Special education teachers: M=4.60, SD=0.55). A Mann-Whitney U test was run on the overall CRS score and each question to determine whether there were significant differences between science teachers’ answers and special education teachers’ answers. The results of this test can be found in Table 4.6.

Table 4.6 Mann-Whitney U Test Results Comparing Science and Special Education Teachers’ Responses on the Co-Teacher Relationship Scale

	Teacher Type	Mean Rank	Sum of Ranks	Mann-Whitney U	Sig.
Sum of Answers on the Co-Teacher Relationship Scale	Science Teachers (N=12)	9.71	116.50	21.500	0.368
	Special Education Teachers (N=5)	7.30	36.50		

Science teachers and special education teachers did not significantly differ on the CRS overall or on any of the individual questions. Full test results for each question can be found in Appendix E. A Kruskal-Wallis H test was also performed on the data to determine if there were any significant differences between co-teachers who had been with their co-teaching partner for 0-1 year, 2-4 years, or 5 or more years. No significant differences were found between groups for the overall CRS or any individual question (see Appendix F for table).

4.2.2 Interview Responses

Several themes emerged in the interview responses related to Research Question 1. These themes include relationships, roles, comfort with abilities, learning from each other, and impact on students. Table 4.7 contains definitions and examples for each theme. The interview responses will be presented in detail in the discussion.

Table 4.7 Interview Response Themes for Research Question 1

Code/Theme	Definition	Example
Relationships	Responses in this category dealt with the participants' descriptions of how they viewed their relationship with their co-teaching partner.	Martin (Science Teacher): My relationship with [my co-teacher] is really well. Like I said, we both coach football together. We've known each other for 10 plus years.
Roles	These responses dealt with participants beliefs or statements about the roles of their co-teachers or themselves in the classroom.	Denise (Science Teacher): There doesn't seem to be an expectation, for them to be like actively teaching. They're more focused on their one on one interactions with their specific students that I have in the room.
Comfort with Abilities	Responses were placed in this category if the participant mentioned their level of comfort with their own abilities or the abilities of their partner related to content knowledge or teaching students with special needs.	Martin: Again, I don't think they fully understand the chemistry, or they haven't had enough chemistry exposure, so they don't always understand the end game.
Learning From Each Other	These responses included participants' descriptions of concepts, practices, and/or knowledge they learned by interacting with their co-teacher.	Gordon (Special Education Teacher): We've both learned, I mean. And content wise, obviously I mean you know I'll go in there, and you know, always pick up on something that, you know I may have forgotten, you know from many, many years ago.

Table 4.7 (Continued)

Code/Theme	Definition	Example
Impact on Students	Response in this category focused on participants' descriptions of how co-teaching impacts their students.	Denise: Always beneficial. Even the least partnership co-teaching experience I've had, I still feel the students are benefiting for sure. Even just as far as having like another set of eyes last year with the co-teacher who's now retired she was really observant and so she would see like little things that were occurring.

4.3 Research Question 2

Data from interviews and the AWRCT was used to provide evidence for research question 2:

> To what extent are secondary science teachers practicing co-teaching with a special education teacher in their classrooms?

4.3.1 Are We Really Co-Teachers Rating Scale

The participants' responses on the AWRCT provided evidence for their perception of co-teaching implementation in their science classrooms. The survey asked teachers to "indicate the average frequency at which you and your co-teacher implement the following practices," with a scale ranging from 1 (once a week or less) to 5 (daily actions). Means and standard deviations for teachers' answers on the AWRCT can be found in Table 4.8.

Table 4.8 Means and Standard Deviations for Teachers' Answers on the Are We Really Co-Teaching Rating Scale. The Scale Ranges from 1 (Once a Week or Less) to 5 (Daily Actions)

	Overall Mean *N*=14	Science Teachers *N*=12	Special Education Teachers *N*=5
Total AWRCT Score	112.43 (23.92)	110.11 (25.12)	116.60 (23.76)
Q1	2.43 (1.70)	1.89 (1.54)	3.40 (1.67)
Q2	3.07 (1.64)	3.11 (1.90)	3.00 (1.22)
Q3	2.57 (1.65)	2.67 (1.87)	2.40 (1.34)
Q4	3.00 (1.96)	3.33 (2.00)	2.40 (1.95)
Q5	4.21 (1.25)	4.22 (1.30)	4.20 (1.30)
Q6	1.93 (1.54)	1.67 (1.32)	2.40 (1.95)
Q7	3.29 (1.86)	3.00 (1.94)	3.80 (1.79)
Q8	2.29 (1.49)	2.00 (1.32)	2.80 (1.79)
Q9	2.14 (1.66)	2.00 (1.58)	2.40 (1.95)
Q10	4.71 (0.61)	4.89 (0.33)	4.40 (0.89)

Table 4.8 (Continued)

	Overall Mean *N*=14	Science Teachers *N*=12	Special Education Teachers *N*=5
Q11	4.71 (0.61)	4.67 (0.71)	4.80 (0.45)
Q12	3.86 (1.35)	4.33 (1.00)	3.00 (1.58)
Q13	3.50 (1.74)	3.44 (1.88)	3.60 (1.67)
Q14	3.07 (1.69)	3.00 (1.80)	3.20 (1.64)
Q15	4.07 (1.38)	4.22 (1.30)	3.80 (1.64)
Q16	3.71 (1.64)	4.11 (1.45)	3.00 (1.87)
Q17	3.43 (1.65)	3.78 (1.72)	2.80 (1.48)
Q18	4.21 (1.19)	4.78 (0.44)	3.20 (1.48)
Q19	4.50 (0.94)	4.67 (1.00)	4.20 (0.84)
Q20	3.43 (1.74)	3.00 (2.00)	4.20 (0.84)

Table 4.8 (Continued)

	Overall Mean *N*=14	Science Teachers *N*=12	Special Education Teachers *N*=5
Q21	3.64 (1.50)	3.89 (1.54)	3.20 (1.48)
Q22	4.57 (0.85)	4.56 (1.01)	4.60 (0.55)
Q23	2.21 (1.72)	2.00 (1.73)	2.60 (1.82)
Q24	3.07 (1.73)	2.89 (1.90)	3.40 (1.52)
Q25	4.50 (0.94)	4.56 (1.01)	4.40 (0.89)
Q26	2.64 (1.69)	2.33 (1.50)	3.20 (2.05)
Q27	4.64 (0.63)	4.67 (0.71)	4.60 (0.55)
Q28	4.50 (1.16)	4.33 (1.41)	4.80 (0.45)
Q29	3.21 (1.81)	2.56 (1.88)	4.40 (0.89)
Q30	4.86 (0.36)	4.89 (0.33)	4.80 (0.45)
Q31	2.71 (1.68)	2.11 (1.45)	3.80 (1.64)

Table 4.8 (Continued)

	Overall Mean *N*=14	Science Teachers *N*=12	Special Education Teachers *N*=5
Q32	2.71 (1.59)	2.00 (1.41)	4.00 (1.00)
Q33	3.57 (1.55)	3.22 (1.64)	4.20 (1.30)
Q34	2.93 (1.86)	2.33 (1.73)	4.00 (1.73)

Participants indicated that the activity that occurred most often in their classrooms was Question 30, "We depend on one another to follow through on tasks and responsibilities," (M= 4.86, SD =0.36). The activity that occurred the least frequently was Question 6, "We share responsibility for deciding what to teach," (M=1.93, SD=1.54).

A Mann-Whitney U test was performed on the data to determine whether there was a significant difference in answers from science teachers and special education teachers. Results of this test can be found in Table 4.9.

Table 4.9 Mann-Whitney U test results for the Are We Really Co-Teachers Rating Scale

	Teacher Type	Mean Rank	Sum of Ranks	Mann-Whitney U	Sig.
Sum of Answers on the Are We Really Co-Teachers Rating Scale	Science Teachers (N=9)	7.22	65.00	20.000	0.739
	Special Education Teachers (N=5)	8.00	40.00		
Question 18. We make improvements in our lessons based on what happens in the classroom.	Science Teachers (N=9)	9.28	83.50	6.500	0.017
	Special Education Teachers (N=5)	4.30	21.50		
Question 32. We are mentors to others who want to co-teach.	Science Teachers (N=9)	5.67	51.00	6.000	0.022
	Special Education Teachers (N=5)	10.80	54.00		

Answers significantly differed between groups on questions 18 (p=0.017) and 32 (p=0.022). On average, science teachers reported that they made "improvements in our lessons based on what happens in the classroom," nearly every day (M=4.78, SD=0.44), while special education teachers reported that they did this an average of approximately three times per week (M=3.20, SD=1.48). Special education teachers reported that they

were “mentors to others who want to co-teach,” an average of four times a week (M=4.00, SD=1.00), while science teachers reported that they did this for an average of two times per week (M=2.00, SD=1.41). The results of the Mann-Whitney U test for all AWRCT questions can be found in Appendix G.

A Kruskal-Wallis H test was also run on AWRCT data to determine whether there were significant differences between co-teaching experience groups. A Kruskal-Wallis H test with post-hoc pairwise comparisons revealed a statistically significant difference (p= 0.017) between participants with 0-1 years of co-teaching with the same partner and participants with 2-4 years of co-teaching with the same partner on question 6 of the AWRCT. Participants with 0-1 years together (mean = 1.00) believed they only shared responsibility for deciding what to teach on average once a week while pairs with 2-4 years of experience (mean= 2.86) reported that they did this at least twice a week. Only two teachers (29% of participants) in the 2-4 years of experience group reported that they shared responsibility for deciding what to teach once a week.

Table 4.10 Significant Kruskal-Wallis H Test Results for the AWRCT.

	Years with Current Partner	Mean Rank	Kruskal-Wallis H	df	Sig.
	0-1 (*N*=5)	5.00			
Q6	2-4 (*N*=7)	10.00	6.832	2	0.033
	5 or More (*N*=2)	5.00			

No other significant differences between experience groups were found for the AWRCT. Full results from the Kruskal-Wallis H test can be found in Appendix H.

4.3.2 Interview Responses

Several themes emerged in the interview responses related to Research Question 2. These themes include expectations, attendance, planning, workload, and student perception. Table 4.11 contains definitions and examples for each theme. The interview responses will be presented in detail in the discussion.

Table 4.11 Interview Response Themes for Research Question 2

Code/Theme	Definition	Example
Expectations	Responses in this category focused on guidelines or a lack thereof for co-teaching set by schools or districts.	Denise (Science Teacher): I don't know if what he's doing is exactly what he's supposed to be doing or if I should be asking for more, reaching out more, I have no idea. So I'm just kind of like, okay, this is what we're doing but there's been no communication on how we're supposed to be co teaching together.
Attendance	These responses focused on the presence of the special education teacher in the science classroom.	Martin (Science Teacher): He's present every day in the classroom. I've had some issues before in the past with some co teachers, that would just disappear for a week or weeks on end and then just say, well, I have a bunch of paperwork, I had a bunch of ARC meetings. They really wouldn't communicate that very well.

Table 4.11 (Continued)

Code/Theme	Definition	Example
Planning	Responses in this category dealt with planning practices of co-teaching teams.	Martin: Our co teaching collaboration will go on from about three o'clock to about three oh five just kind of debriefing on the day and then talking about what comes next. We'll usually email or text each other some stuff if we have some ideas.
Workload	These responses deal with the division of the workload within the co-taught science classroom.	SR: Talking about the division of workload in the science class, do you feel like you take on the brunt of the responsibility for like modifying or differentiating for students? Gordon (Special Education Teacher): And no, actually not and sometimes it's, again it's our teachers know our students well enough.
Student Perception	Responses in this category focused on how students viewed the participants and their co-teachers in terms of roles in the classroom.	Denise: Yeah they view me as the teacher for sure, and I think there, I think that his specific particular students that are on his caseload view him also as a teacher, but the other students in the class do not

4.4 Research Question 3

Data from both the CRS and the AWRCT was used to explore research question 3:

> How do teachers' perceptions of their co-teaching relationships affect the implementation of co-teaching?

To run this analysis, the data was first matched. Only data from teachers that had completed both the AWRCT and the CRS was retained (*N*=14). Data from teachers that only completed the CRS but not the AWRCT was not used in this portion of the analysis (*N*=3). Results from the regression analysis can be found in Table 4.12.

Table 4.12 Regression results used to determine whether CRS score significantly impacted AWRCT score

	B	SE B	β	Sig.
CRS	0.481	0.815	0.168	0.566

Notes. $R = 0.168$, $R^2 = 0.028$, $F=0.349$, $p= 0.566$

This study revealed no significant relationship (p=0.556) between scores on the CRS and scores on the AWRCT. At this time, the null hypothesis that teachers' perception of their co-teaching relationship does not impact the implementation of co-teaching in their classrooms must be retained.

4.5 Participant Reflection and Ideas for Improvement

During the interviews, participants were asked to reflect on their co-teaching practices to identify areas that they believe needed improvement. Once these areas were identified, the participants were asked to provide examples of things they could do, or things their districts could do, to improve or better support their co-teaching practices. Major themes from these discussions can be found in Table 4.13.

Table 4.13 Interview Response Themes Related to Reflection and Ideas for Improving Co-Teaching

Code/Theme	Definition	Example
Training	Responses in this category dealt with the participants desire for training related to co-teaching.	Martin (Science Teacher): I think annual training, or every other year training should definitely be a priority, if not, I'd actually prefer annual training, just to kind of give us that, even if it's not PD training just an annual event at the beginning of the year, where we get more time.to work on best practices. I mean it's like anything in education and anything in science, things are always changing.
PLC Time	These responses detailed participants' experiences with including co-teachers in their Professional Learning Communities within their schools.	Martin: We do have PLC time together but PLC time doesn't always allow us to collaborate as directly as we would like again because we're taking care of other business.
Planning	Responses in this category related to participants' experiences lesson planning with their co-teaching partner. Responses may also deal with participant recommendations for district supported planning time for co-teaching teams.	Denise (Science Teacher): I think if we had some designated time to plan together, I think that would be a huge help if we could just like, even if it was me like 15-20 minutes, bringing up like hey here's the lesson that are like the lessons I have planned, or this is where we're going. What right now, do you think we should do for our kids in question and just having some actual time in the day designated to discuss our group and what needs to happen.
Choosing Co-Teachers	Responses focus on why the participants were chosen to co-teach.	Gordon (Special Education Teacher): A lot of times it's just on my schedule, you know, and it never bothers me, but you know my having an Ag background I guess you know. I know it's not the same curriculum, don't, I'm not equating that but, at the same time I've got a pretty good knowledge of science, and you know everything that we would deal with in there.

The response themes for the interviews have been combined into one table within Appendix I.

CHAPTER 5. DISCUSSION

5.1 Participants

An interesting pattern emerged when looking at participant demographics. A large percentage of teachers (41%) had only been with their current co-teaching partner for one year. Only two teachers (12%) reported that they co-taught with the same partner for five or more years even though the majority of teachers (65%) reported that they had been co-teaching science courses for five or more years. This may suggest that schools do not prioritize keeping teams together when scheduling courses so that co-teachers can build a better partnership, although it should be noted that the data in this study does not support a relationship between perception of co-teacher relationships and co-teaching implementation.

One interview participant, Martin, stated that in his 10 years of experience, he had had six different co-teachers. When asked why he thought that was the case, he said that he believed it was because none of his co-teachers were comfortable enough with the content and did not understand the course progression. He said that the special education teachers seemed to want to leave science and stick with social studies or English courses because they were more comfortable with the content. He reiterated he had never had a co-teacher stick with him for more than two years before they asked to move to social studies or English. Another participant, Gordon, stated that he had co-taught in science for 14 years, but at his school, he would get placed in the courses with the highest need. Gordon had been a special education teacher for over 20 years and stated that in the years he was not co-teaching in science, he would be co-teaching in English or Math because there

would always be a co-teacher in those courses. This suggests that his district places higher value in co-teaching in literacy and math courses.

5.2 Research Question 1

Research question 1 sought to understand how teachers perceive their co-teaching relationships and the implementation of co-teaching in their classrooms. When looking at the average scores for the CRS in Table 4.5, the majority of scores were above 4.0, indicating that the survey participants believed they were similar to their co-teachers in terms of beliefs about teaching and approaches to teaching. Similar to results found in Cramer and Nevin's (2006) study, the most highly rated items in this study were Q6 Beliefs about inclusion (M: 4.47; SD: 0.72), Q10 Views regarding parent involvement (M: 4.47; SD: 0.87), Q17 Ability to be supportive to colleagues and other staff (M: 4.65; SD: 0.61), and Q19 Dedication to teaching (M: 4.71; SD: 0.47). These responses support the idea that teachers view co-teaching and inclusion positively. The notion that co-teachers feel that their partner is supportive and dedicated to co-teaching is also supported by this data.

Items with low scores indicate that teachers believe they and their co-teacher hold different views in those areas. The CRS items with the lowest average scores in this study were Q3 Views regarding how to structure children's activities (M: 3.71; SD: 0.77), Q9 Beliefs about teacher roles and responsibilities (M: 4.12; 1.17), and Q14 Approaches to educational planning (M: 3.76; SD: 1.20). These results suggest that while teachers are seemingly happy to have a co-teacher in the classroom, they do not always agree on how best to structure a lesson or what each teacher should be doing in the classroom.

Differences in perception between science teachers and special educators were examined, but like Malian and McRae's (2010) study, this study found no significant differences on any of the survey items or on the overall CRS score. This study also examined if there were statistically significant differences in survey responses across three experience groups, 0-1 year, 2-4 years, and 5 or more years of co-teaching experience with the same partner. No significant differences were found.

5.2.1 Relevant Interview Responses

Several themes emerged from the interview responses that were relevant to research question 1. These themes include relationships, roles, comfort with abilities, learning from each other, and impact on students.

5.2.1.1 Relationships

When speaking about their relationships with their co-teachers, interview participants would always find something positive to say about their co-teacher. For example, when asked about his relationship with his co-teacher, Martin provided the following response:

> Martin (Science Teacher): My relationship with [my co-teacher] is really well. Like I said, we both coach football together. We've known each other for 10 plus years. He is very student relationship friendly like he really takes time to build those relationships with the students to get to know them to know what kind of help they need. So whenever we're co-teaching he does a good job of injecting stuff that is more common sense. Sometimes I can kind of go nerd and like talk about things

that are way off topic or way too in depth, for a lot of kids to where he does a good job of kind of reiterating things to real world experiences and tying things into his own career before he came into education.

Martin had a prior, friendly relationship with his co-teacher through coaching and while his co-teacher was new to education, Martin made sure to explain that his partner was a great resource for the students even though they did not have time to plan together.

However, even when participants had positive things to say about their co-teachers, they were quick to point out flaws in their co-teaching relationship. For example, Denise was impressed by her co-teacher's attendance, but still felt as if they were not truly a team. When asked to compare her current co-teaching partnership to her co-teaching experience at a much larger, urban school, Denise had this to say:

Denise (Science Teacher): Much less of a partnership. I think here they're seen as a support and at [larger school], it was way more of an actual partnership. My co-teacher would teach lessons themselves and we would kind of tag team the whole class together.

When asked about his relationship with his science co-teacher, Gordon, a special education teacher pointed out that it was more difficult to build relationships with the science teacher because he was not given the opportunity to co-teach in those classes as often as he co-taught in English or Math courses.

SR: Do you have a better relationship with your science co-teacher?

> Gordon: Really no, I don't because and it goes back to what I said previously, is that co teaching opportunities in a science class are fewer than there are in English. I'm always going to be in an English class; I'm always going to be in a math class. So me being in those situations are just a given. Science, probably this year I'll, there's a lot more possibility of being in a science classroom because we've got some extremely low students that will be taking it. It'll be their biology year, some will be their chemistry year, so there's a really good chance of that happening.

It should be noted that Gordon followed the trend of saying positive things about his science co-teachers even when he viewed those relationships as less productive related to co-teaching when compared to English or math co-teaching.

5.2.1.2 Roles

Two of the three interview participants confirmed that their co-teaching practices were geared toward the one teach-one assist model, while the final participant (Martin) stated that he and his co-teacher would try other models such as station teaching or working with different groups of students at the same time. Despite these statements, the final participant still mentioned that he was the "pilot" of the classroom and did most of the planning for the class.

Denise seemed to feel like the main problem with her co-teaching relationship was that the district provided no expectations or guidance on how she and her partner were supposed to co-teach. She stated that she felt comfortable with her partner but did not feel comfortable bringing up issues of co-teaching styles with him.

Denise: There doesn't seem to be an expectation, for them to be like actively teaching. They're more focused on their one-on-one interactions with their specific students that I have in the room.

While Gordon wanted to be seen as more of an equal partner, he felt like his lack of a solid relationship with his science co-teacher (and his English co-teacher) was causing him to be seen as an assistant. He stated that he would love to be able to teach more of the lessons, but often fell back into the role of resource teacher.

Gordon: Science, you know and I'm science and math I mean that's my background I could probably feel more comfortable in saying okay here's this week's lesson, you know, give me the lesson, and let me teach it. A lot of times my roles, and I'm going to speak more towards co-teaching like an English class, even though this is not our conversation, but I will say in a lot of those cases I'm truly there as a resource I'm not there to teach the lesson. I feel like that my talents are not being used in that class nearly as much as they would be in a math class.

In contrast, when speaking about co-teaching in his other disciplines, especially math, Gordan said "I think that they just, they're willing to just give me those reins a little bit more."

Unlike Denise and Gordon, Martin felt comfortable with the division of roles in his classroom.

Martin: Yeah you really wouldn't know which one of us was the co-teacher if you just came in for five or 10 minutes. You would probably pick up on that I was

because I probably give a little bit more prompting in terms of the instructional pacing. But, uh, you know, we do a lot of think pair share we do a lot of collaborative stuff.

Martin did have the highest total score on the AWRCT, indicating that he believed he was practicing the 34 items related to co-teaching more frequently than Denise or Gordon believed that they were. These responses are also supported by previous studies (King-Sears et al., 2014; Scruggs et al., 2007) that have also found the primary co-teaching model in science is one-teach, one-assist where the special education teacher provides support while the science teacher delivers the content.

5.2.1.3 Comfort with Abilities

Denise seemed to be an outlier in this category. While Martin and Gordon were both comfortable with having the special education teacher take over to teach science lessons, or just saying they were comfortable with the special education teacher's content knowledge, Denise stated that she did not have confidence in her partner's ability to teach science content.

SR: Are you comfortable with your partner's level of knowledge when it comes to your course? Would you trust them to teach your bio content?

Denise: No, not here. Not my current one, no.

SR: Did you feel differently at [larger school]?

Denise: Yes, I did. I, and I honestly I was… nope, yep just [larger school].

SR: Taking his current content knowledge into account, do you think if it was more of a partnership, would you feel more comfortable with that, if you were planning with him and stuff?

Denise: Yeah I, I just don't know what he knows. I haven't seen enough. There hasn't been enough communication. He might be very well versed and I would have no idea, um, so absolutely.

While Denise was not confident in her partner's content knowledge, this seems to stem from a lack of time to actually work with her partner outside of the class period.

In contrast to some of the cited background literature (Kahn & Lewis, 2014; Maeng & Bell, 2015; Mumba et al., 2015), the three participants were confident in the ability of the science content teacher to teach students with special needs.

SR: Think about the opposite role, thinking about your most recent co-teacher, do you feel comfortable in their abilities to teach students with special needs?

Gordon: I do, where, I'll speak to our district. We're a small district, we have approximately 1200, 1100 to 1200, students district wide K through 12. Our students are blessed, or our teachers are blessed, either way it's a two-way street, we have great relationships, you know. We develop those relationships with our students and, they're good with working with special needs students, as well you know they'll… chances are you'll see a teacher, the gen ed teacher working as closely with those kids as much as I would in those classrooms and so it's, it's really, it's a really good setting for both the student and the teacher and for the teacher and the student. Both ways, because most students do at the end, you know, your,

> I guess you'd say your general student population would never know, you know, that a student would be in there with special needs, because they don't see the teacher or myself working solely with just those students.

While Gordon stated that he did not have the closest relationship with his science co-teacher, he was still very comfortable with them teaching students with special needs. Martin echoed Gordon's sentiments in that Martin stated that it would be difficult to tell which teacher was the special education teacher if one were to walk into his classroom. While Denise was not comfortable with her partner's ability to teach science, she stated that she was comfortable teaching students with special needs on her own, although she did say she would sometimes need help with modifying certain assignments.

5.2.1.4 Learning From Each Other

The theoretical framework for this study is situated learning theory and communities of practice. This study sought to uncover whether a true partnership or community of practice had formed in the participants' classrooms. To give evidence for this piece, interview participants were asked if they had ever learned anything from their co-teachers or if they thought their co-teachers had ever learned anything from them. The hope in asking these questions was to see if situated learning theory could be applied in co-teaching settings to say that content teachers learn how to teach students with special needs and special education teachers learn content specific knowledge. All three participants stated that co-teaching had been beneficial to their own practice.

> SR: Would you say you've learned anything from your co-teachers?

Denise: Oh absolutely, all of them in one way or another. Um so at [larger school] my co teacher, she was like excellent at finding the connections between like students own interest, and so she really got to know her kids well and she could bring it in and make it work for like whatever we were talking about. So that's something I'm always trying to do. My co-teacher last year that has since retired had 50 plus years of experience so the skill I gained from her was not babying the students that are on her caseload. She was very direct. She was from up North so she talked very plainly, there were no like sugarcoating things. But her students responded really well to that that that directness they knew the expectations and so it kind of let me see that I could be more, not forceful, but like direct, make definitive statements and it wouldn't be like, they're not fragile if that makes any sense. Especially for our are ones that are on the Autistic spectrum and tend to read into things too much, it was very effective for them. And then this year his ability to take what I'm doing and modify it in the moment was something I picked up on, and would start to do and so like when we were walking around if he was working with a student I would go to one of his other kids and I could help modify for them in the moment because of the things I would see him do so, I learned from them always yes.

Once again, even though Denise did not have a great deal of confidence in her current co-teacher or his content knowledge, she had positive things to say about his skill as a special education teacher. She stated that she was able to learn from watching how he modified materials during class periods even though they did not have time to work together outside of the class. When asked if she was comfortable teaching students with special needs, being

able to modify materials was one of the main example Denise gave for why she was comfortable.

Martin also stated that he learned how to make modifications to materials due to working with his co-teacher.

> Martin: But yeah just understanding more about wait times and modifications and appropriate modifications. My first two co-teachers, their modifications were really just like either give them additional time or mark half the multiple choice answers off and I'm like, that's not really a modification, it seems like you're just giving them a 50-50 shot. Now I understand how to use more lexicon ratings and if I'm going to give an article review or use more diversity in student voice it's student choice activities, so students have things that they feel comfortable with as opposed to it being a one size fits all. I feel like I learned that from another one of my other co-teachers about five years ago.

5.2.1.5 Impact on Students

Interview participants had a very positive view of how co-teaching impacts their students. Many felt like it promoted inclusion, and none felt as if there was any stigma placed on the students with special needs. All participants stated that they worked with all students in the classroom and did not leave a certain group of students to only work with one of the teachers. However, Denise did state that her current co-teacher tended to want to focus on the students on his caseload. Martin and Gordon did not face that problem. When asked how co-teaching impacts their students, the participants had this to say:

> Denise: Always beneficial, even the least partnership co teaching experience I've had, I still feel the students are benefiting for sure. Even just as far as having like another set of eyes last year with the Co teacher who's now retired. She was really observant and so she would see like little things that were occurring, maybe some like social interactions that maybe weren't the greatest and she would address them and pull kids out and have conversations with them, and so, when they came back in they… she would address it before it became a situation that got out of control, which is something I have tried to be better at. But I get caught up in the content or caught up with what we're doing and I miss some of those little things so that was something she was really good at picking up on.

That was also another example of Denise watching her co-teacher and wanting to learn from them.

> Martin: Students really like it and I think that's changed a little bit. The stigma is that students used to understand that there were to two teachers in there and you're probably in one of the classes with the IEP kids toward now I think they're looking more of it like a, you have two teachers in there, you have two people that are going to give you attention and give you feedback and give you a relationship and just give you a support and that's what [my co-teacher] brought to us, is that, as you know, the kids enjoy him whether they're IEP students or not IEP students, they cut up with him. Like they tell them stories, jokes, it's much more of a collaborative atmosphere amongst not just myself and him but also from teacher to student relationship it's just it's like a big democracy and him and I may be Presidents but we're listening to feedback from everybody else.

Gordon said, “I think it’s a tremendous benefit,” and provided an example of how co-teaching benefits all students in a math class he is a co-teacher in. When speaking about showing students an alternate way to approach graphing:

> Gordon: I’m doing it to get to my students but you'll also see other ones saying oh now I see it, because before they didn't see how that problem was to be worked so, you know, I’m giving that opportunity for those general ed students to also you know, see the benefit of you know… Yeah it, it may make it elementary in in the view of what I’m teaching with slope or looking at a graph. But it's also benefiting more than one more than just the two or three students and I’m really doing it for.

Gordon always speaks highly of his math co-teacher because she gives him the freedom to teach the students or show how to work problems at the board. He expressed many times that he wished that his science co-teacher would allow him to teach or take control more often.

5.2.2 Summary

Much like what Dieker and Rodriguez (2013) stated in their paper, the three participants believed that having two teachers in the classroom was beneficial to the students because two teachers working together are better able to meet the needs of all students in the classroom. Survey responses indicated that teachers generally believed they were similar to their co-teacher in both approaches to teaching and dispositions related to teaching. There were no significant differences between general and special educators on any of the survey responses for the CRS. There were also no differences between experience groups on any of the survey items.

Interview participants generally felt that they had positive views of their co-teachers in terms of comfort and ability to rely on their co-teacher to help in the classroom. Interview participants did express a desire to have more of an ideal co-teaching relationship in which they were equal members of a team. They wanted time carved into their schedules to plan together, to talk about student needs, and to learn how to use different co-teaching models. None of them felt that they were an ideal co-teaching team and all felt that they had a great deal of room for improvement.

5.3 Research Question 2

Research question 2 sought to understand the extent to which co-teaching is being practiced in secondary science classrooms. Scores on the AWRCT and interview responses were used to explore this research question. Similar to Cramer and Nevin (2006), teachers rated Q10 "We are flexible and make changes as needed during a lesson," highly (M: 4.71; SD: 0.61) indicating that this occurred nearly daily. Other near daily occurrences include Q11 "We identify student strengths and needs," (M: 4.71; SD: 0.61), Q19 "We communicate freely our concerns," (M: 4.50; SD: 0.94), Q22 "We have fun with the students and with each other when we co-teach," (M: 4.57; SD: 0.85), Q25 "We can effectively co-teach even when we don't have time to plan," (M: 4.50; SD: 0.94), Q27 "We model collaboration and teamwork for our students," (M: 4.64; SD: 0.63), Q28 "We are both viewed by our students as their teacher," (M: 4.50; SD: 1.16), and Q30 "We depend on one another to follow through on tasks and responsibilities," (M: 4.86; SD: 0.36).

Items on the AWRCT that received the lowest scores indicated that these practices occurred less than two days per week. These items include Q1 "We decide which co-

teaching model we are going to use in a lesson based on the benefits to the students and the co-teachers," (M: 2.43; SD: 1.70), Q6 "We share responsibility for deciding what to teach," (M: 1.96; SD: 1.54), Q8 "We share responsibility for deciding how to teach," (M: 2.29; SD 1.49), Q9 "We share responsibility for deciding who teaches which part of a lesson," (M: 2.14; SD: 1.66), and Q23 "We have regularly scheduled times to meet and discuss our work," (M: 2.21; SD: 1.72). These responses seem to indicate that there is a power imbalance such that one of the teachers in co-teaching pairs seems to take control of lesson planning and pacing. Responses also provide evidence that co-teaching teams are not given enough opportunities to plan together. Based on results of the Kruskal-Wallis H Test (Table 4.10), there is evidence that teams that are able to co-teach together for 2 or more years are more likely to share responsibility for deciding what to teach (Q6).

5.3.1 Relevant Interview Responses

Several themes from interview responses were related to research question 2 and implementation of co-teaching. These themes include expectations, attendance, planning, workload, and student perception. Also noteworthy, Denise reported the lowest amount of co-teaching implementation in her classroom and when looking at Table 4.4, one can see that a larger proportion of students in her school scored at the novice level than students at Martin or Gordon's schools.

5.3.1.1 Expectations

Interview participants spoke about expectations set forth by their districts related to co-teaching and training for co-teaching. Two participants, Martin and Gordon, stated that their districts provided training or professional development for co-teaching, while Denise

stated that her district had never provided training or any sort of expectations for what co-teaching should look like in her classroom.

> Denise: I don't know if what he's doing is exactly what he's supposed to be doing or if I should be asking for more, reaching out more, I have no idea. So I’m just kind of like, okay, this is what we're doing but there's been no communication on how we're supposed to be co teaching together.

> Denise: there doesn't seem to be an expectation, for them to be like actively teaching they're more focused on their one-on-one interactions with their specific students that I have in the room. That just seems to be the way it's done, and so I think that's the expectations that they have so I haven't I’ve never actually questioned it or brought it up.

Martin stated that his district would go through cycles in which they would focus on co-teaching and then would drop it for a few years before cycling back to it in a few years.

> Martin: there's a lot of support there's a lot of like we would like to see you all do this, we'd like to see this documented, we'd like to see evidence of this. It's just that seems to be where it stops is, we would like to see you do this stuff we prefer you all do these things, but we don't see a ton of support in terms of actual practical resources or training. I keep mentioning four or five years ago, because I know that was a time where we had a two-day co teaching a workshop at the very beginning of the school year.

Gordon said that his district did offer training on co-teaching, and he planned to participate in a professional development program in the summer, but as far as expectations, he said that the district did not put forth guidelines for co-teaching.

> Gordon: If a teacher is having an observation done and I'm in that classroom, you know, I will be acknowledged in that co-teaching assignment for that teacher because, you know, you're not going to see me sitting on my hands, I mean that's, one that's not in my character, so. But that's really about it there's no saying this is okay, this is what we expect to see.

These findings suggest that teachers would like to be able to more effectively co-teach but are not provided adequate support or professional development opportunities from their districts. The teachers seem to believe they are doing the best they can with their limited resources.

5.3.1.2 Attendance

The two science teachers that participated in the interviews, Denise and Martin, made sure to bring attention to the fact that their co-teachers were present in every class period and that they appreciated their presence.

> Martin: He's present every day in the classroom. I've had some issues before in the past with some co teachers, that would just disappear for a week or weeks on end and then just say, well, I have a bunch of paperwork, I had a bunch of Arc meetings. They really wouldn't communicate that very well.

Denise: They were there, their attendance is awesome. Like I have heard other co-teachers in my building are kind of iffy on whether or not they will show up and be there, but mine have always been very present.

These findings suggest that the science teachers value the presence and input of their special education co-teacher and resent when the co-teacher has to attend to other responsibilities that take them out of the classroom.

5.3.1.3 Planning

Planning emerged as an important theme in the interview responses. All three interview participants expressed a desire to have more time to plan lessons with their co-teacher.

Martin: Our co teaching collaboration will go on from about three o'clock to about three oh five just kind of debriefing on the day and then talking about what comes next. We'll usually email or text each other some stuff if we have some ideas.

Denise: Yeah just more of a partnership in general, would be fantastic.

SR: Can you think of any ways that you might be able to achieve that in the future with this current partner?

Denise: I think if we had some designated time to plan together, I think that would be a huge help if we could just like, even if it was only like 15-20 minutes, bringing up like, hey here's the lessons I have planned or this is where we're going, what right now do you think we should do for our kids in question and just having some actual time in the day designated to discuss our group and what needs to happen.

These findings may be partially responsible for some of the lower scoring items on the AWRCT as teachers cannot decide how to split responsibility in deciding what and how to teach if they are not given time to plan together.

5.3.1.4 Workload

When asked about the workload division in their classrooms, the three participants had varied answers. Denise only stated that she did a lot more than her co-teacher as he only came in during her class periods to help specific students. Martin and Gordon had a more positive view of the division of work.

> SR: Talking about the division of workload in the science class, do you feel like you take on the brunt of the responsibility for like modifying or differentiating for students?
>
> Gordon: And no, actually not and sometimes it's, again it's our teachers know our students well enough.

Gordon noted that the science teachers had good enough relationships with the students that they were able to make necessary modifications to course materials to meet student needs on their own.

> Martin: So I'm probably the pilot of you know, the direction the class goes, and you know I control the direction and the pacing and things like that. In terms of modifications that's more equally split up. Like I said a minute ago, he's more proactive and seeing things coming on the horizon and kind of making modifications or thinking about modifications that we can work on together to better fit our kids' needs.

Martin made sure to note that their partnership still was not perfect because his partner was still new and learning the basics of teaching. He also noted that the modifications his partner did suggest were usually suggested via email or text since they did not have time to plan together.

These findings still suggest that the science teacher is taking on the most responsibility in the co-taught courses. Interview responses indicate that science teachers are doing most of the course planning and, as science teachers are becoming more confident in their abilities to modify course materials, they are relying less on the co-teacher.

5.3.1.5 Student Perception

Survey responses indicated that teachers believe their students view them both as the teacher in the classroom. With the exception of Denise, interview responses support these findings.

> Denise: Yeah they view me as the teacher for sure, and I think there, I think that his specific particular students that are on his caseload view him also as a teacher, but the other students in the class do not.

Denise never mentioned her co-teacher doing anything other than interacting with the students with special needs so it would make sense that the general education students would not view him as their teacher. The other two participants indicated that their students viewed both teachers as their teacher, although Gordon stated that the students were definitely aware of which teacher was the science teacher and which teacher was the special education teacher.

Martin: I think this year they saw it as equal footing because I noticed that they would ask, they asked [my co-teacher] a lot of questions. They would ask him a lot of things about their assignments, or what we were doing that day. I think they still ultimately see me as the as the head teacher just because my name is on the door and they know they're in my classroom but students, IEP or not, were very willing to work with [my co-teacher].

5.3.2 Summary

Based on the survey data and interview responses, teachers in this study are not practicing co-teaching as effectively as they could be. Data shows that teachers are not planning for the course together, nor are they equally sharing the workload in the class. The interview participants expressed a sincere desire to receive training or planning time so that they could fully implement co-teaching in their classrooms because they believe that co-teaching is beneficial for all students in their classrooms. The data for Q1 of the AWRCT and interview responses also indicate that teachers are not choosing different co-teaching models to implement and are relying on the one-teach, one-assist model in their classrooms.

5.4 Research Question 3

Research question 3 sought to understand if there was a relationship between relationship scores on the CRS and implementation scores on the AWRCT. To explore this question, a linear regression analysis was performed on the dataset. A significant relationship was not found and the null hypothesis that relationship score had no effect on implementation score was retained.

In support of the lack of a relationship between scores on the CRS and scores on the AWRCT, while Martin had the highest AWRCT score, he had a much lower score than Denise on the CRS. Martin was much more comfortable with his co-teacher and seemed to believe that they were doing a good job at co-teaching which is counterintuitive to a relatively low CRS score. Denise had the highest CRS score of the three interview participants, but her interview responses indicated that she was practicing co-teaching the least, with her co-teacher only coming into the classroom to provide support for the students with disabilities. These findings are in contrast to the previous study by Haimowitz (2018) which found a significant relationship between attitudes and implementation of co-teaching. However, Haimowitz (2018) did not use the CRS to measure relationships or attitudes.

5.5 Limitations

The biggest limitation of this study is the sample size. As the sample size is so small, it is impossible to say the results are generalizable to the larger population of co-teachers in secondary science courses. The results of this study are, however, useful in providing evidence for how co-teaching is currently practiced in Kentucky public high schools, especially in the Green River Regional Educational Cooperative as most of the participants worked in that region. It should be noted that although the response rate for the survey seems to be extremely low, it is very likely that the number of science co-teachers in relation to the number of science teachers and special education teachers contacted is also very low. In my personal experience, a school may have six science teachers but only two of those science teachers have the opportunity to co-teach with a special education teacher. Those two science teachers probably share the same special

education teacher as well since many schools seem to assign one special educator to any courses within one content area. It is also unknown how many districts in Kentucky are actually practicing co-teaching in science. Multiple teachers and principals emailed the researcher to indicate that their schools only practiced co-teaching in literacy and mathematics courses. Research is needed to establish the number of secondary schools that practice co-teaching in science and to understand why some districts do not value co-teaching in science courses. Another limitation is that the data did not come from matched pairs of science and special educators. No co-teaching pairs responded to the surveys at all.

It is believed that the global pandemic impacted teachers' practice to the extent that teachers became unwilling to discuss co-teaching due to their perception of their own implementation as poor, as evidenced by interview responses in this study. Ideally, this research may be attempted again when schools return to normal operation to see if more teachers are willing to participate.

Final limitations lie in the instruments. Particularly related to Research Question 3, the instruments may not have been measuring the exact information needed to fully answer the research question. For example, the CRS asks teachers to indicate the extent to which they believe they are similar to or different than their co-teacher partner. However, questions arise when pondering whether this instrument is truly measuring the teachers' perception of their relationship and how that might relate to implementation. While the instrument focuses on whether teachers believe they have similar views on teaching and values as their partners, it does not ask questions about whether the co-teachers feel valued, respected, or liked by their partners which may also be important relationship measures.

5.6 Implications for Practice

Similar to findings from previous studies (King-Sears et al., 2014; Scruggs et al., 2007), survey and interview responses indicate that teachers have positive feelings toward the practice of co-teaching but feel like school and district support is lacking. Interview participants were asked to elaborate on the level of support districts gave them for co-teaching and about their ideas for district improvement related to co-teaching. Themes in their responses include training, PLC time, planning time, and choosing co-teachers.

5.6.1 Recommendations for Improvement

Participants indicated that districts should make the following improvements to support co-teaching practices.

1. Training – the participants believe that districts should offer annual training or professional development so that teachers could understand the district's expectations of them related to co-teaching. Gordon mentioned that he had never been evaluated on co-teaching but would like to see some sort of expectations for what he should be doing in the classroom.
2. PLC Time – Participants indicated that districts should implement time for special education teachers to participate in the science professional learning communities at their schools and that PLC time should include time to co-plan lessons with co-teachers.
3. Planning – Participants stated that districts should instate common planning time for co-teachers to effective plan for courses, choose co-teaching models,

and make necessary modifications in course materials for students with special needs.

Another theme that emerged was how districts and schools chose people to co-teach. Teachers were simply chosen because of their backgrounds or because of the courses they taught. It may prove beneficial for districts or schools to think about the qualities and dispositions each teacher would bring to a co-teaching team before making teaching assignments.

Within this study, teachers have expressed a sincere desire to be able to co-teach effectively because they believe it would have a positive impact on the students. It is hoped that districts will listen to these teachers' voices and provide the time and training supports necessary for their co-teaching teams to thrive.

5.7 Conclusion

Teachers have positive views of their co-teaching relationships. They seem to believe that they and their partners are doing their best with the resources they've been given. The data, including interview responses suggests that co-teaching teams do not feel as if they are implementing co-teaching as well as they could be. Based on CRS data, this could be due to differences in beliefs and dispositions related to planning and roles. This perception did not significantly differ between experience groups or teacher types.

Teaching teams are not fully implementing co-teaching. As evidenced by the lowest scoring items on the AWRCT, teams are not planning together, they are not sharing the workload, and they are not choosing different co-teaching models together. Teachers with 2-4 years of experience with the same partner were more likely to report sharing

responsibility for deciding what to teach, but this still occurred infrequently. Perception of co-teaching relationship appears to have no effect on implementation of co-teaching. Most teachers had a positive perception of the co-teacher even when they self-reported a lack of true co-teaching.

This study adds to the literature in that most articles reviewed did not accompany their claims about co-teaching in science with quantitative data. This study demonstrates that secondary science co-teaching pairs are not adequately implementing co-teaching but are willing to improve their co-teaching practices because they believe co-teaching is beneficial for the students. They feel that their districts and schools are not providing adequate resources and training to support them.

APPENDICES

Appendix A

The Co-Teacher Relationship Scale (Noonan et al., 2003, p. 115). This questionnaire will be presented to teachers via Qualtrics. Response for each item will range from 1 (very different) to 5 (very similar).

Co-Teacher Questionnaire Items

Indicate the extent to which you believe you and your co-teacher are the same or different in your beliefs and approaches to teaching, and personal/professional characteristics and style.

1. Views regarding the physical arrangement of the classroom.
2. Views regarding classroom scheduling.
3. Views regarding how to structure children's activities.
4. Beliefs about what the curriculum for young children should be.
5. Beliefs about how children learn.
6. Beliefs about inclusion.
7. Views about how to adapt and individualize activities.
8. Views about how to manage inappropriate behavior.
9. Beliefs about teacher roles and responsibilities.
10. Views regarding parent involvement.
11. Desire to try new things.
12. Confidence as an educator.
13. Ways of dealing with colleagues, supervisors, parents, and other professionals.
14. Approaches to educational planning.
15. Flexibility in dealing with unforeseen events.
16. Sense of humor.
17. Ability to be supportive to colleagues and other staff.
18. Interest in learning new things.
19. Dedication to teaching.

Appendix B

The Are We Really Co-Teaching Rating Scale as found in Villa et al., 2013, pp. 380-382.

Are We Really Co-Teachers?

Directions: Check Yes or No for each of the following statements to determine your Co-Teaching Score at this point in time.

Yes	*No*	*In our co-teaching partnership*
		1. We decide which co-teaching model we are going to use in a lesson based on the benefits to the students and the co-teachers.
		2. We share ideas, information, and materials.
		3. We identify the resources and talents of the co-teachers.
		4. We teach different groups of students at the same time.
		5. We are aware of what our co-teacher(s) is doing even when we are not directly in one another's presence.
		6. We share responsibility for deciding what to teach.
		7. We agree on the curriculum standards that will be addressed in a lesson.
		8. We share responsibility for deciding how to teach.
		9. We share responsibility for deciding who teaches which part of a lesson.
		10. We are flexible and make changes as needed during a lesson.
		11. We identify student strengths and needs.
		12. We share responsibility for differentiating instruction.
		13. We include other people when their expertise or experience is needed.
		14. We share responsibility for how student learning is assessed.
		15. We can show that students are learning when we co-teach.
		16. We agree on discipline procedures and carry them out jointly.
		17. We give feedback to one another on what goes on in the classroom.
		18. We make improvements in our lessons based on what happens in the classroom.
		19. We communicate freely our concerns.
		20. We have a process for resolving our disagreements and use it when faced with problems and conflicts.
		21. We celebrate the process of co-teaching and the outcomes and successes.
		22. We have fun with the students and with each other when we co-teach.

Yes	*No*	*In our co-teaching partnership*
		23. We have regularly scheduled times to meet and discuss our work.
		24. We use our meeting time productively.
		25. We can effectively co-teach even when we don't have time to plan.
		26. We explain the benefits of co-teaching to the students and their families.
		27. We model collaboration and teamwork for our students.
		28. We are both viewed by our students as their teacher.
		29. We include students in the co-teaching role.
		30. We depend on one another to follow through on tasks and responsibilities.
		31. We seek and enjoy additional training to make our co-teaching better.
		32. We are mentors to others who want to co-teach.
		33. We can use a variety of co-teaching approaches (i.e., supportive, parallel, complementary, team teaching).
		34. We communicate our need for logistical support and resources to our administrators.
		TOTAL

Appendix C

The combined survey that was sent to teachers.

Co-Teaching in Secondary Science

Start of Block: Block 1

Q2 Do you consider yourself a co-teacher in a secondary level science classroom?

- Yes (1)
- No (2)

Skip To: End of Survey If Do you consider yourself a co-teacher in a secondary level science classroom? = No

Q3 Are you either a science content teacher or a licensed special education teacher?

- Yes, I am a science content teacher (1)
- Yes, I am a licensed special education teacher (2)
- No (3)

Skip To: End of Survey If Are you either a science content teacher or a licensed special education teacher? = No

End of Block: Block 1

Start of Block: Block 3

Q4 What is your name?

_____

Q5 What is your email address?

_____

Q6 How many years have you been a teacher?

- 0-1 year (1)
- 2-4 years (2)
- 5 or more years (3)

Q7 Have many years have you co-taught with your current co-teaching partner?

- 0-1 year (1)
- 2-4 years (2)
- 5 or more years (3)

Q8 How many total years have you co-taught secondary science courses?

_____

Q13 What is the name of the high school in which you work?

_____

Q14 What is your current co-teacher's name?

_____

End of Block: Block 3

Start of Block: Block 3

Q16 Indicate the extent to which you believe you and your co-teacher are the same or different in your beliefs and approaches to teaching, and personal/professional characteristics and style.

	Very different (1)	Moderately different (2)	Neutral (3)	Moderately similar (4)	Very similar (5)
1. Views regarding the physical arrangement of the classroom. (1)	○	○	○	○	○
2. Views regarding classroom scheduling. (2)	○	○	○	○	○
3. Views regarding how to structure students' activities. (3)	○	○	○	○	○
4. Beliefs about what the curriculum for our students should be. (4)	○	○	○	○	○
5. Beliefs about how students learn. (5)	○	○	○	○	○
6. Beliefs about inclusion. (6)	○	○	○	○	○
7. Views about how to adapt and individualize activities. (7)	○	○	○	○	○
8. Views about how to manage inappropriate behavior. (8)	○	○	○	○	○
9. Beliefs about teacher roles and responsibilities. (9)	○	○	○	○	○
10. Views regarding parent involvement. (10)	○	○	○	○	○
11. Desire to try new things. (11)	○	○	○	○	○
12. Confidence as an educator. (12)	○	○	○	○	○
13. Ways of dealing with colleagues, supervisors, parents, and other professionals. (13)	○	○	○	○	○
14. Approaches to educational planning. (14)	○	○	○	○	○
15. Flexibility in dealing with unforeseen events. (15)	○	○	○	○	○
16. Sense of humor. (16)	○	○	○	○	○
17. Ability to be supportive to colleagues and other staff. (17)	○	○	○	○	○
18. Interest in learning new things. (18)	○	○	○	○	○
19. Dedication to teaching. (19)	○	○	○	○	○

End of Block: Block 3

Q17 Indicate the average frequency at which you and your co-teacher implement the following practices

	Once a week or less (1)	Twice a week (2)	Three times a week (3)	Four times a week (4)	Daily Actions (5)
1. We decide which co-teaching model we are going to use in a lesson based on the benefits to the students and the co-teachers. (1)	○	○	○	○	○
2. We share ideas, information, and materials. (2)	○	○	○	○	○
3. We identify the resources and talents of the co-teachers. (3)	○	○	○	○	○
4. We teach different groups of students at the same time. (4)	○	○	○	○	○
5. We are aware of what our co-teacher is doing even when we are not directly in one another's presence. (5)	○	○	○	○	○
6. We share responsibility for deciding what to teach. (6)	○	○	○	○	○
7. We agree on the curriculum standards that	○	○	○	○	○

will be addressed in a lesson. (7)					
8. We share responsibility for deciding how to teach. (8)	0	0	0	0	0
9. We share responsibility for deciding who teaches which part of a lesson. (9)	0	0	0	0	0
10. We are flexible and make changes as needed during a lesson. (10)	0	0	0	0	0
11. We identify student strengths and needs. (11)	0	0	0	0	0
12. We share responsibility for differentiating instruction. (12)	0	0	0	0	0
13. We include other people when their expertise or experience is needed. (13)	0	0	0	0	0
14. We share responsibility for how student learning is assessed. (14)	0	0	0	0	0
15. We can show that students are learning when we co-teach. (15)	0	0	0	0	0
16. We agree on discipline procedures and carry them out jointly. (16)	0	0	0	0	0
17. We give feedback to one another on what goes on in the classroom. (17)	0	0	0	0	0
18. We make improvements in our lessons based on what happens in the classroom. (18)	0	0	0	0	0
19. We communicate freely our concerns. (19)	0	0	0	0	0
20. We have a process for resolving our disagreements and use it when faced with problems and conflicts. (20)	0	0	0	0	0
21. We celebrate the process of co-teaching and the outcomes and successes. (21)	0	0	0	0	0
22. We have fun with the students and with each other when we co-teach. (22)	0	0	0	0	0
23. We have regularly	0	0	0	0	0

scheduled times to meet and discuss our work. (23)					
24. We use our meeting time productively. (24)	○	○	○	○	○
25. We can effectively co-teach when we don't have time to plan. (25)	○	○	○	○	○
26. We explain the benefits of co-teaching to the students and their families. (26)	○	○	○	○	○
27. We model collaboration and teamwork for our students. (27)	○	○	○	○	○
28. We are both viewed by our students as their teacher. (28)	○	○	○	○	○
29. We include students in the co-teaching role. (29)	○	○	○	○	○
30. We depend on one another to follow through on tasks and responsibilities. (30)	○	○	○	○	○
31. We seek and enjoy additional training to make our co-teaching	○	○	○	○	○

better. (31)					
32. We are mentors to others who want to co-teach. (32)	○	○	○	○	○
33. We can use a variety of co-teaching approaches (i.e., supportive, parallel, complementary, team teaching). (33)	○	○	○	○	○
34. We communicate our need for logistical support and resources to our administrators. (34)	○	○	○	○	○

End of Block: Block 4

Start of Block: Block 5

Q18

Would you be willing to participate in an individual interview with the researcher to discuss co-teaching?

○ Yes (1)

○ No (2)

Q19 Would you be willing to allow the researcher to observe you and your co-teacher for one co-taught class period?

- ○ Yes (1)
- ○ No (2)

End of Block: Block 5

Appendix D

Interview Protocol

Teaching History

1. How long have you been a teacher?
2. What is your area of specialty (science or special education)?
3. How long have you taught within that specialty?
4. Why do you think you were chosen to co-teach science?
5. What unique experiences or dispositions do you bring to your role as a co-teacher?

Current Practices

6. Describe your relationship and the level of comfort with your co-teacher.
7. Describe your level of comfort with the content and working with the students in the classroom.
8. What would the ideal co-teaching practice look like in your classroom? How do your current practices compare?
9. How do you and your partner prepare for class together?
10. How would you describe the division of the workload in the class between you and your co-teacher?
11. How do you think the students view you and view your partner in the classroom?
12. (If content teacher) Describe your level of comfort with your partner's knowledge of the content.
13. (If special educator) Describe your level of comfort with your partner's knowledge of working with students in special education.
14. Have you ever learned anything from your co-teacher?

Reflection

15. How do you think coteaching impacts your students?
16. Provide a specific example of how co-teaching has helped or hindered student learning in your classroom.
17. How is co-teaching impacting your teaching practices?
18. Which areas of your current practice do you think need the most improvement?
19. How would you improve those practices?
20. Describe the level of support you receive for your coteaching practices.
21. Which aspects of coteaching do you feel are adequately supported?
22. Which aspects of coteaching do you feel need further support?
23. What supports do you recommend that schools/districts provide for teachers engaged in coteaching? What would help you the most if you had access to it?

Appendix E

Appendix Table 1 Mann-Whitney U test results for the total score and individual question scores from the Co-Teacher Relationship Scale.

	Teacher Type	Mean Rank	Sum of Ranks	Mann-Whitney U	Sig.
Sum of Answers on the Co-Teacher Relationship Scale	Science Teachers (N=12)	9.71	116.50	21.500	0.368
	Special Education Teachers (N=5)	7.30	36.50		
Q1. Views regarding the physical arrangement of the classroom.	Science Teachers (N=12)	9.04	108.50	29.500	0.954
	Special Education Teachers (N=5)	8.90	44.50		
Q2. Views regarding classroom scheduling.	Science Teachers (N=12)	9.50	114.00	24.000	0.498
	Special Education Teachers (N=5)	7.80	39.00		

Appendix Table 1 (Continued)

	Teacher Type	Mean Rank	Sum of Ranks	Mann-Whitney U	Sig.
Q3. Views regarding how to structure students' activities.	Science Teachers (N=12)	9.13	109.50	28.500	0.844
	Special Education Teachers (N=5)	8.70	43.50		
Q4. Beliefs about what the curriculum for our students should be.	Science Teachers (N=12)	10.08	121.00	17.000	0.119
	Special Education Teachers (N=5)	6.40	32.00		
Q5. Beliefs about how students learn.	Science Teachers (N=12)	9.50	114.00	24.000	0.505
	Special Education Teachers (N=5)	7.80	39.00		

Appendix Table 1 (Continued)

	Teacher Type	Mean Rank	Sum of Ranks	Mann-Whitney U	Sig.
Q6. Beliefs about inclusion.	Science Teachers (N=12)	10.33	124.00	14.000	0.055
	Special Education Teachers (N=5)	5.80	29.00		
Q7. Views about how to adapt and individualize activities.	Science Teachers (N=12)	9.42	113.00	25.000	0.574
	Special Education Teachers (N=5)	8.00	40.00		
Q8. Views about how to manage inappropriate behavior.	Science Teachers (N=12)	9.63	115.50	22.500	0.401
	Special Education Teachers (N=5)	7.50	37.50		

Appendix Table 1 (Continued)

	Teacher Type	Mean Rank	Sum of Ranks	Mann-Whitney U	Sig.
Q9. Beliefs about teacher roles and responsibilities.	Science Teachers (N=12)	9.83	118.00	20.000	0.254
	Special Education Teachers (N=5)	7.00	35.00		
Q10. Views regarding parent involvement.	Science Teachers (N=12)	9.83	118.00	20.000	0.214
	Special Education Teachers (N=5)	7.00	35.00		
Q11. Desire to try new things.	Science Teachers (N=12)	10.13	121.50	16.500	0.114
	Special Education Teachers (N=5)	6.30	31.50		

Appendix Table 1 (Continued)

	Teacher Type	Mean Rank	Sum of Ranks	Mann-Whitney U	Sig.
Q12. Confidence as an educator.	Science Teachers (N=12)	9.18	101.00	20.000	0.361
	Special Education Teachers (N=5)	7.00	35.00		
Q13. Ways of dealing with colleagues, supervisors, parents, and other professionals.	Science Teachers (N=12)	8.17	98.00	20.000	0.269
	Special Education Teachers (N=5)	11.00	55.00		
Q14. Approaches to educational planning.	Science Teachers (N=12)	8.50	102.00	24.000	0.506
	Special Education Teachers (N=5)	10.20	51.00		

Appendix Table 1 (Continued)

	Teacher Type	Mean Rank	Sum of Ranks	Mann-Whitney U	Sig.
Q15. Flexibility in dealing with unforeseen events.	Science Teachers (N=12)	8.96	107.50	29.500	0.954
	Special Education Teachers (N=5)	9.10	45.50		
Q16. Sense of humor.	Science Teachers (N=12)	9.38	112.50	25.500	0.602
	Special Education Teachers (N=5)	8.10	40.50		
Q17. Ability to be supportive to colleagues and other staff.	Science Teachers (N=12)	9.50	114.00	24.000	0.428
	Special Education Teachers (N=5)	7.80	39.00		

Appendix Table 1 (Continued)

	Teacher Type	Mean Rank	Sum of Ranks	Mann-Whitney U	Sig.
Q18. Interest in learning new things.	Science Teachers (N=12)	9.42	113.00	25.000	0.553
	Special Education Teachers (N=5)	8.00	40.00		
Q19. Dedication to teaching.	Science Teachers (N=12)	9.38	112.50	25.500	0.549
	Special Education Teachers (N=5)	8.10	40.50		

Appendix F

Appendix Table 2 Kruskal-Wallis H Test Results for the CRS

	Years with Current Partner	Mean Rank	Kruskal-Wallis H	df	Sig.
Overall CRS Score	0-1 (*N*=7)	9.93	0.625	2	0.714
	2-4 (*N*=8)	7.94			
	5 or More (*N*=2)	10.00			
Q1	0-1 (*N*=7)	8.71	0.419	2	0.811
	2-4 (*N*=8)	8.75			
	5 or More (*N*=2)	11.00			
Q2	0-1 (*N*=7)	8.29	1.284	2	0.526
	2-4 (*N*=8)	8.75			
	5 or More (*N*=2)	12.50			
Q3	0-1 (*N*=7)	8.50	0.182	2	0.913
	2-4 (*N*=8)	9.38			
	5 or More (*N*=2)	9.25			

Appendix Table 2 (Continued)

Years with Current Partner	Mean Rank	Kruskal-Wallis H	df	Sig.	Years with Current Partner
	0-1 (*N*=7)	9.79			
Q4	2-4 (*N*=8)	7.75	1.367	2	0.505
	5 or More (*N*=2)	11.25			
	0-1 (*N*=7)	8.86			
Q5	2-4 (*N*=8)	9.00	0.028	2	0.986
	5 or More (*N*=2)	9.50			
	0-1 (*N*=7)	9.29			
Q6	2-4 (*N*=8)	8.81	0.050	2	0.975
	5 or More (*N*=2)	8.75			

Appendix Table 2 (Continued)

	Years with Current Partner	Mean Rank	Kruskal-Wallis H	df	Sig.
	0-1 (*N*=7)	8.71			
Q7	2-4 (*N*=8)	9.63	0.366	2	0.833
	5 or More (*N*=2)	7.50			
	0-1 (*N*=7)	6.50			
Q8	2-4 (*N*=8)	10.75	3.287	2	0.193
	5 or More (*N*=2)	10.75			
	0-1 (*N*=7)	9.71			
Q9	2-4 (*N*=8)	8.69	0.343	2	0.842
	5 or More (*N*=2)	7.75			
	0-1 (*N*=7)	9.00			
Q10	2-4 (*N*=8)	9.19	0.077	2	0.962
	5 or More (*N*=2)	8.25			

Appendix Table 2 (Continued)

	Years with Current Partner	Mean Rank	Kruskal-Wallis H	df	Sig.
	0-1 (*N*=7)	8.64			
Q11	2-4 (*N*=8)	9.25	0.073	2	0.964
	5 or More (*N*=2)	9.25			
	0-1 (*N*=7)	9.08			
Q12	2-4 (*N*=8)	7.75	0.493	2	0.781
	5 or More (*N*=2)	9.75			
	0-1 (*N*=7)	10.07			
Q13	2-4 (*N*=8)	7.19	2.540	2	0.281
	5 or More (*N*=2)	12.50			

Appendix Table 2 (Continued)

	Years with Current Partner	Mean Rank	Kruskal-Wallis H	df	Sig.
	0-1 (*N*=7)	9.79			
Q14	2-4 (*N*=8)	7.56	1.685	2	0.431
	5 or More (*N*=2)	12.00			
	0-1 (*N*=7)	10.00			
Q15	2-4 (*N*=8)	7.94	0.803	2	0.669
	5 or More (*N*=2)	9.75			
	0-1 (*N*=7)	9.50			
Q16	2-4 (*N*=8)	8.44	0.227	2	0.893
	5 or More (*N*=2)	9.50			
	0-1 (*N*=7)	9.21			
Q17	2-4 (*N*=8)	9.50	1.074	2	0.585
	5 or More (*N*=2)	6.25			

Appendix Table 2 (Continued)

	Years with Current Partner	Mean Rank	Kruskal-Wallis H	df	Sig.
	0-1 (*N*=7)	9.79			
Q18	2-4 (*N*=8)	8.25	0.445	2	0.800
	5 or More (*N*=2)	9.25			
	0-1 (*N*=7)	10.29			
Q19	2-4 (*N*=8)	8.31	1.348	2	0.510
	5 or More (*N*=2)	7.25			

Appendix G

Appendix Table 3 Mann-Whitney U Test Results for the Total Score and Individual Question Scores From the Are We Really Co-Teachers Rating Scale

	Teacher Type	Mean Rank	Sum of Ranks	Mann-Whitney U	Sig.
Sum of Answers on the Are We Really Co-Teachers Rating Scale	Science Teachers (N=9)	7.22	65.00	20.000	0.739
	Special Education Teachers (N=5)	8.00	40.00		
Q1. We decide which co-teaching model we are going to use in a lesson based on the benefits to the students and the co-teachers.	Science Teachers (N=9)	6.22	56.00	11.000	0.099
	Special Education Teachers (N=5)	9.80	49.00		
Q2. We share ideas, information, and materials.	Science Teachers (N=9)	7.44	67.00	22.000	0.945
	Special Education Teachers (N=5)	7.60	38.00		
Q3. We identify the resources and talents of the co-teachers.	Science Teachers (N=9)	7.67	69.00	21.000	0.834
	Special Education Teachers (N=5)	7.20	36.00		

Appendix Table 3 (Continued)

	Years with Current Partner	Mean Rank	Kruskal-Wallis H	df	Sig.
Q4. We teach different groups of students at the same time.	Science Teachers (N=9)	8.33	75.00	15.000	0.277
	Special Education Teachers (N=5)	6.00	30.00		
Q5. We are aware of what our co-teacher is doing even when we are not directly in one another's presence.	Science Teachers (N=9)	7.44	67.00	22.000	0.940
	Special Education Teachers (N=5)	7.60	38.00		
Q6. We share responsibility for deciding what to teach.	Science Teachers (N=9)	7.17	64.50	19.500	0.640
	Special Education Teachers (N=5)	8.10	40.50		
Q7. We agree on the curriculum standards that will be addressed in a lesson.	Science Teachers (N=9)	6.94	62.50	17.500	0.470
	Special Education Teachers (N=5)	8.50	42.50		

Appendix Table 3 (Continued)

	Years with Current Partner	Mean Rank	Kruskal-Wallis H	df	Sig.
Q8. We share responsibility for deciding how to teach.	Science Teachers (N=9)	6.89	62.00	17.000	0.442
	Special Education Teachers (N=5)	8.60	43.00		
Q9. We share responsibility for deciding who teaches which part of a lesson.	Science Teachers (N=9)	7.22	65.00	20.000	0.697
	Special Education Teachers (N=5)	8.00	40.00		
Q10. We are flexible and make changes as needed during a lesson.	Science Teachers (N=9)	8.28	74.50	15.500	0.193
	Special Education Teachers (N=5)	6.10	30.50		
Q11. We identify student strengths and needs.	Science Teachers (N=9)	7.39	66.50	21.500	0.853
	Special Education Teachers (N=5)	7.70	38.50		

Appendix Table 3 (Continued)

	Years with Current Partner	Mean Rank	Kruskal-Wallis H	df	Sig.
Q12. We share responsibility for differentiating instruction.	Science Teachers (N=9)	8.83	79.50	10.500	0.084
	Special Education Teachers (N=5)	5.10	25.50		
Q13. We include other people when their expertise or experience is needed.	Science Teachers (N=9)	7.56	68.00	22.000	0.943
	Special Education Teachers (N=5)	7.40	37.00		
Q14. We share responsibility for how student learning is assessed.	Science Teachers (N=9)	7.39	66.50	21.500	0.891
	Special Education Teachers (N=5)	7.70	38.50		
Q15. We can show that students are learning when we co-teach.	Science Teachers (N=9)	8.11	73.00	17.000	0.414
	Special Education Teachers (N=5)	6.40	32.00		

Appendix Table 3 (Continued)

	Years with Current Partner	Mean Rank	Kruskal-Wallis H	df	Sig.
Q16. We agree on discipline procedures and carry them out jointly.	Science Teachers (N=9)	8.56	77.00	13.000	0.173
	Special Education Teachers (N=5)	5.60	28.00		
Q17. We give feedback to one another on what goes on in the classroom.	Science Teachers (N=9)	8.39	75.50	14.500	0.262
	Special Education Teachers (N=5)	5.90	29.50		
Q18. We make improvements in our lessons based on what happens in the classroom.	Science Teachers (N=9)	9.28	83.50	6.500	0.017
	Special Education Teachers (N=5)	4.30	21.50		
Q19. We communicate freely our concerns.	Science Teachers (N=9)	8.56	77.00	13.000	0.112
	Special Education Teachers (N=5)	5.60	28.00		

Appendix Table 3 (Continued)

	Years with Current Partner	Mean Rank	Kruskal-Wallis H	df	Sig.
Q20. We have a process for resolving our disagreements and use it when faced with problems and conflicts.	Science Teachers (N=9)	6.83	61.50	16.500	0.398
	Special Education Teachers (N=5)	8.70	43.50		
Q21. We celebrate the process of co-teaching and the outcomes and successes.	Science Teachers (N=9)	8.28	74.50	15.500	0.328
	Special Education Teachers (N=5)	6.10	30.50		
Q22. We have fun with the students and with each other when we co-teach.	Science Teachers (N=9)	7.83	70.50	19.500	0.614
	Special Education Teachers (N=5)	6.90	34.50		
Q23. We have regularly scheduled times to meet and discuss our work.	Science Teachers (N=9)	6.94	62.50	17.500	0.457
	Special Education Teachers (N=5)	8.50	42.50		

Appendix Table 3 (Continued)

	Years with Current Partner	Mean Rank	Kruskal-Wallis H	df	Sig.
Q24. We use our meeting time productively.	Science Teachers (N=9)	7.22	65.00	20.000	0.729
	Special Education Teachers (N=5)	8.00	40.00		
Q25. We can effectively co-teach when we don't have time to plan.	Science Teachers (N=9)	7.89	71.00	19.000	0.558
	Special Education Teachers (N=5)	6.80	34.00		
Q26. We explain the benefits of co-teaching to the students and their families.	Science Teachers (N=9)	6.83	61.50	16.500	0.402
	Special Education Teachers (N=5)	8.70	43.50		
Q27. We model collaboration and teamwork for our students.	Science Teachers (N=9)	7.83	70.50	19.500	0.614
	Special Education Teachers (N=5)	6.90	34.50		

Appendix Table 3 (Continued)

	Years with Current Partner	Mean Rank	Kruskal-Wallis H	df	Sig.
Q28. We are both viewed by our students as their teacher.	Science Teachers (N=9)	7.33	66.00	21.000	0.781
	Special Education Teachers (N=5)	7.80	39.00		
Q29. We include students in the co-teaching role.	Science Teachers (N=9)	6.11	55.00	10.000	0.079
	Special Education Teachers (N=5)	10.00	50.00		
Q30. We depend on one another to follow through on tasks and responsibilities.	Science Teachers (N=9)	7.72	69.50	20.500	0.661
	Special Education Teachers (N=5)	7.10	35.50		
Q31. We seek and enjoy additional training to make our co-teaching better.	Science Teachers (N=9)	6.06	54.50	9.500	0.068
	Special Education Teachers (N=5)	10.10	50.50		

Appendix Table 3 (Continued)

	Years with Current Partner	Mean Rank	Kruskal-Wallis H	df	Sig.
Q32. We are mentors to others who want to co-teach.	Science Teachers (N=9)	5.67	51.00	6.000	0.022
	Special Education Teachers (N=5)	10.80	54.00		
Q33. We can use a variety of co-teaching approaches (i.e., supportive, parallel, complementary, team teaching).	Science Teachers (N=9)	6.61	59.50	14.500	0.265
	Special Education Teachers (N=5)	9.10	45.50		
Q34. We communicate our need for logistical support and resources to our administrators.	Science Teachers (N=9)	6.28	56.50	11.500	0.117
	Special Education Teachers (N=5)	9.70	48.50		

Appendix H

Appendix Table 4 Kruskal-Wallis H Test Results for the AWRCT.

	Years with Current Partner	Mean Rank	Kruskal-Wallis H	df	Sig.
Overall AWRCT Score	0-1 (*N*=5)	8.00	0.118	2	0.943
	2-4 (*N*=7)	7.29			
	5 or More (*N*=2)	7.00			
Q1	0-1 (*N*=5)	5.80	4.835	2	0.089
	2-4 (*N*=7)	9.71			
	5 or More (*N*=2)	4.00			
Q2	0-1 (*N*=5)	6.60	2.916	2	0.233
	2-4 (*N*=7)	6.86			
	5 or More (*N*=2)	12.00			
Q3	0-1 (*N*=5)	7.20	0.099	2	0.952
	2-4 (*N*=7)	7.50			
	5 or More (*N*=2)	8.25			

Appendix Table 4 (Continued)

	Years with Current Partner	Mean Rank	Kruskal-Wallis H	df	Sig.
	0-1 (*N*=5)	7.60			
Q4	2-4 (*N*=7)	7.43	0.006	2	0.997
	5 or More (*N*=2)	7.50			
	0-1 (*N*=5)	8.10			
Q5	2-4 (*N*=7)	6.21	2.259	2	0.323
	5 or More (*N*=2)	10.50			
	0-1 (*N*=5)	5.00			
Q6	2-4 (*N*=7)	10.00	6.832	2	0.033
	5 or More (*N*=2)	5.00			

Appendix Table 4 (Continued)

	Years with Current Partner	Mean Rank	Kruskal-Wallis H	df	Sig.
	0-1 (*N*=5)	8.20			
Q7	2-4 (*N*=7)	7.21	0.278	2	0.870
	5 or More (*N*=2)	6.75			
	0-1 (*N*=5)	7.30			
Q8	2-4 (*N*=7)	8.79	2.749	2	0.253
	5 or More (*N*=2)	3.50			
	0-1 (*N*=5)	6.70			
Q9	2-4 (*N*=7)	8.79	2.129	2	0.345
	5 or More (*N*=2)	5.00			
	0-1 (*N*=5)	7.70			
Q10	2-4 (*N*=7)	6.93	0.776	2	0.678
	5 or More (*N*=2)	9.00			

Appendix Table 4 (Continued)

	Years with Current Partner	Mean Rank	Kruskal-Wallis H	df	Sig.
	0-1 (*N*=5)	7.40			
Q11	2-4 (*N*=7)	7.14	0.605	2	0.739
	5 or More (*N*=2)	9.00			
	0-1 (*N*=5)	9.70			
Q12	2-4 (*N*=7)	6.36	2.529	2	0.282
	5 or More (*N*=2)	6.00			
	0-1 (*N*=5)	7.90			
Q13	2-4 (*N*=7)	7.50	0.185	2	0.912
	5 or More (*N*=2)	6.50			

Appendix Table 4 (Continued)

	Years with Current Partner	Mean Rank	Kruskal-Wallis H	df	Sig.
	0-1 (*N*=5)	7.80			
Q14	2-4 (*N*=7)	7.29	0.047	2	0.977
	5 or More (*N*=2)	7.50			
	0-1 (*N*=5)	8.90			
Q15	2-4 (*N*=7)	7.00	1.2562	2	0.534
	5 or More (*N*=2)	5.75			
	0-1 (*N*=5)	7.90			
Q16	2-4 (*N*=7)	7.50	0.185	2	0.912
	5 or More (*N*=2)	6.50			
	0-1 (*N*=5)	9.60			
Q17	2-4 (*N*=7)	6.21	2.193	2	0.334
	5 or More (*N*=2)	6.75			

Appendix Table 4 (Continued)

	Years with Current Partner	Mean Rank	Kruskal-Wallis H	df	Sig.
	0-1 (*N*=5)	10.50			
Q18	2-4 (*N*=7)	5.86	4.974	2	0.081
	5 or More (*N*=2)	5.75			
	0-1 (*N*=5)	9.50			
Q19	2-4 (*N*=7)	5.50	5.038	2	0.081
	5 or More (*N*=2)	9.50			
	0-1 (*N*=5)	7.90			
Q20	2-4 (*N*=7)	6.07	3.001	2	0.223
	5 or More (*N*=2)	11.50			

Appendix Table 4 (Continued)

	Years with Current Partner	Mean Rank	Kruskal-Wallis H	df	Sig.
	0-1 (*N*=5)	8.20			
Q21	2-4 (*N*=7)	7.29	0.300	2	0.861
	5 or More (*N*=2)	6.50			
	0-1 (*N*=5)	7.80			
Q22	2-4 (*N*=7)	6.71	1.161	2	0.560
	5 or More (*N*=2)	9.50			
	0-1 (*N*=5)	7.90			
Q23	2-4 (*N*=7)	8.07	1.498	2	0.473
	5 or More (*N*=2)	4.50			
	0-1 (*N*=5)	6.80			
Q24	2-4 (*N*=7)	7.93	0.239	2	0.887
	5 or More (*N*=2)	7.75			

Appendix Table 4 (Continued)

	Years with Current Partner	Mean Rank	Kruskal-Wallis H	df	Sig.
	0-1 (*N*=5)	9.50			
Q25	2-4 (*N*=7)	5.50	5.038	2	0.081
	5 or More (*N*=2)	9.50			
	0-1 (*N*=5)	9.70			
Q26	2-4 (*N*=7)	7.07	3.610	2	0.164
	5 or More (*N*=2)	3.50			
	0-1 (*N*=5)	9.50			
Q27	2-4 (*N*=7)	5.50	5.091	2	0.078
	5 or More (*N*=2)	9.50			

Appendix Table 4 (Continued)

	Years with Current Partner	Mean Rank	Kruskal-Wallis H	df	Sig.
	0-1 (*N*=5)	7.40			
Q28	2-4 (*N*=7)	7.14	0.602	2	0.740
	5 or More (*N*=2)	9.00			
	0-1 (*N*=5)	7.60			
Q29	2-4 (*N*=7)	7.43	0.005	2	0.997
	5 or More (*N*=2)	7.50			
	0-1 (*N*=5)	8.50			
Q30	2-4 (*N*=7)	6.50	2.167	2	0.338
	5 or More (*N*=2)	8.50			
	0-1 (*N*=5)	6.30			
Q31	2-4 (*N*=7)	8.14	0.710	2	0.701
	5 or More (*N*=2)	8.25			

Appendix Table 4 (Continued)

	Years with Current Partner	Mean Rank	Kruskal-Wallis H	df	Sig.
	0-1 (*N*=5)	5.60			
Q32	2-4 (*N*=7)	7.29	4.871	2	0.088
	5 or More (*N*=2)	13.00			
	0-1 (*N*=5)	7.10			
Q33	2-4 (*N*=7)	6.64	2.371	2	0.306
	5 or More (*N*=2)	11.50			
	0-1 (*N*=5)	6.00			
Q34	2-4 (*N*=7)	7.29	3.393	2	0.183
	5 or More (*N*=2)	12.00			

Appendix I

Appendix Table 5 Full Set of Interview Response Themes

Code/Theme	Definition	Example
Relationships	Responses in this category dealt with the participants' descriptions of how they viewed their relationship with their co-teaching partner.	Martin: My relationship with [my co-teacher] is really well. Like I said, we both coach football together. We've known each other for 10 plus years.
Roles	These responses dealt with participants beliefs or statements about the roles of their co-teachers or themselves in the classroom.	Denise: There doesn't seem to be an expectation, for them to be like actively teaching. They're more focused on their one on one interactions with their specific students that I have in the room.
Comfort with Abilities	Responses were placed in this category if the participant mentioned their level of comfort with their own abilities or the abilities of their partner related to content knowledge or teaching students with special needs.	Martin: Again, I don't think they fully understand the chemistry, or they haven't had enough chemistry exposure, so they don't always understand the end game.
Learning From Each Other	These responses included participants' descriptions of concepts, practices, and/or knowledge they learned by interacting with their co-teacher.	Gordon: We've both learned, I mean. And content wise, obviously I mean you know I'll go in there, and you know, always pick up on something that, you know I may have forgotten, you know from many, many years ago.

Appendix Table 5 (Continued)

Code/Theme	Definition	Example
Impact on Students	Response in this category focused on participants' descriptions of how co-teaching impacts their students.	Denise: Always beneficial. Even the least partnership co-teaching experience I've had, I still feel the students are benefiting for sure. Even just as far as having like another set of eyes last year with the co-teacher who's now retired she was really observant and so she would see like little things that were occurring.
Expectations	Responses in this category focused on guidelines or a lack thereof for co-teaching set by schools or districts.	Denise: I don't know if what he's doing is exactly what he's supposed to be doing or if I should be asking for more, reaching out more, I have no idea. So I'm just kind of like, okay, this is what we're doing but there's been no communication on how we're supposed to be co teaching together.
Attendance	These responses focused on the presence of the special education teacher in the science classroom.	Martin: He's present every day in the classroom. I've had some issues before in the past with some co teachers, that would just disappear for a week or weeks on end and then just say, well, I have a bunch of paperwork, I had a bunch of Arc meetings. They really wouldn't communicate that very well.

Appendix Table 5 (Continued)

Code/Theme	Definition	Example
Planning	Responses in this category dealt with planning practices of co-teaching teams.	Martin: Our co teaching collaboration will go on from about three o'clock to about three oh five just kind of debriefing on the day and then talking about what comes next. We'll usually email or text each other,some stuff if we have some ideas.
Workload	These responses deal with the division of the workload within the co-taught science classroom.	SR: Talking about the division of workload in the science class, do you feel like you take on the brunt of the responsibility for like modifying or differentiating for students? Gordon: And no, actually not and sometimes it's, again it's our teachers know our students well enough.
Student Perception	Responses in this category focused on how students viewed the participants and their co-teachers in terms of roles in the classroom.	Denise: Yeah they view me as the teacher for sure, and I think there, I think that his specific particular students that are on his caseload view him also as a teacher, but the other students in the class do not

Appendix Table 5 (Continued)

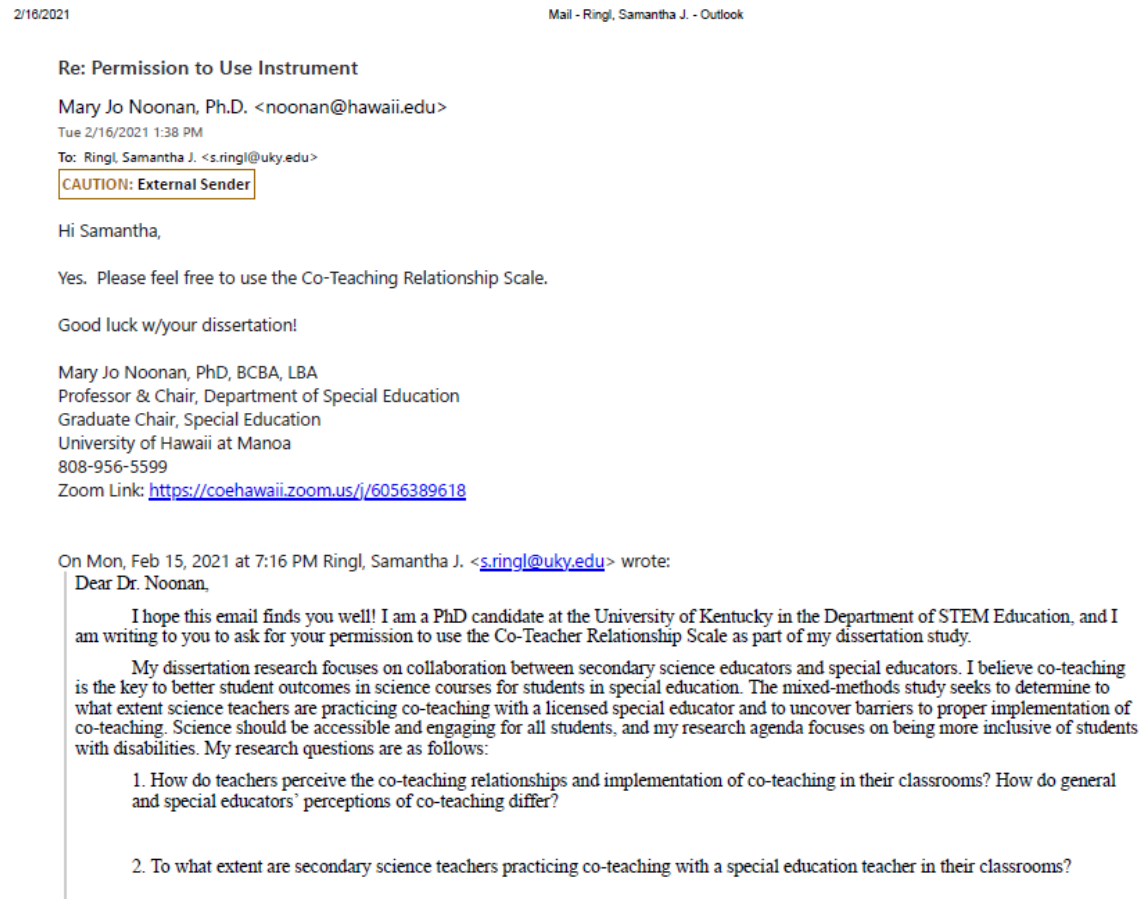
Code/Theme	Definition	Example
Training	Responses in this category dealt with the participants desire for training related to co-teaching.	Martin: I think annual training, or every other year training should definitely be a priority, if not, I'd actually prefer annual training, just to kind of give us that, even if it's not PD training just an annual event at the beginning of the year, where we get more time.to work on best practices. I mean it's like anything in education and anything in science, things are always changing.
PLC Time	These responses detailed participants' experiences with including co-teachers in their Profession Learning Communities within their schools.	Martin: We do have PLC time together but PLC time doesn't always allow us to collaborate as directly as we would like again because we're taking care of other business.
Planning	Responses in this category related to participants' experiences lesson planning with their co-teaching partner. Responses may also deal with participant recommendations for district supported planning time for co-teaching teams.	Denise: I think if we had some designated time to plan together, I think that would be a huge help if we could just like, even if it was me like 15-20 minutes, bringing up like hey here's the lesson that are like the lessons I have planned, or this is where we're going. What right now, do you think we should do for our kids in question and just having some actual time in the day designated to discuss our group and what needs to happen.

Appendix Table 5 (Continued)

Code/Theme	Definition	Example
Choosing Co-Teachers	Responses focus on why the participants were chosen to co-teach.	Gordon: A lot of times it's just on my schedule, you know, and it never bothers me, but you know my having an Ag background I guess you know. I know it's not the same curriculum, don't, I'm not equating that but, at the same time I've got a pretty good knowledge of science, and you know everything that we would deal with in there.

Appendix J

Permission to use the CRS.



2/16/2021 Mail - Ringl, Samantha J. - Outlook

Re: Permission to Use Instrument

Mary Jo Noonan, Ph.D. <noonan@hawaii.edu>
Tue 2/16/2021 1:38 PM
To: Ringl, Samantha J. <s.ringl@uky.edu>
CAUTION: External Sender

Hi Samantha,

Yes. Please feel free to use the Co-Teaching Relationship Scale.

Good luck w/your dissertation!

Mary Jo Noonan, PhD, BCBA, LBA
Professor & Chair, Department of Special Education
Graduate Chair, Special Education
University of Hawaii at Manoa
808-956-5599
Zoom Link: https://coehawaii.zoom.us/j/6056389618

On Mon, Feb 15, 2021 at 7:16 PM Ringl, Samantha J. <s.ringl@uky.edu> wrote:

Dear Dr. Noonan,

I hope this email finds you well! I am a PhD candidate at the University of Kentucky in the Department of STEM Education, and I am writing to you to ask for your permission to use the Co-Teacher Relationship Scale as part of my dissertation study.

My dissertation research focuses on collaboration between secondary science educators and special educators. I believe co-teaching is the key to better student outcomes in science courses for students in special education. The mixed-methods study seeks to determine to what extent science teachers are practicing co-teaching with a licensed special educator and to uncover barriers to proper implementation of co-teaching. Science should be accessible and engaging for all students, and my research agenda focuses on being more inclusive of students with disabilities. My research questions are as follows:

1. How do teachers perceive the co-teaching relationships and implementation of co-teaching in their classrooms? How do general and special educators' perceptions of co-teaching differ?

2. To what extent are secondary science teachers practicing co-teaching with a special education teacher in their classrooms?

Appendix K

Permission to use the AWRCT.

Re: Permission to Use Instrument

ravillabayridge@cs.com <ravillabayridge@cs.com>
Wed 2/17/2021 3:46 PM
To: Ringl, Samantha J. <s.ringl@uky.edu>
Cc: jthousan@csusm.edu <jthousan@csusm.edu>

1 attachments (68 KB)
Co-Teaching & Inclusion manuscript with title page.docx;

CAUTION: **External Sender**

Samantha,

You have permission to use our instrument, "*Are We Really Co-Teachers*" as part of your dissertation study as

long as you reference the source. Your study sounds interesting and we hope that you will share your findings with us.

I have attached a copy of a co-teaching journal article submitted for publication and a chapter on co-teaching from our Inclusive Education Checklist: A Self-Assessment of Best Practices. We thought they might be of assistance in your study.

Best of luck,

Rich and Jacque

Richard A. Villa, Ed. D.
President, Bayridge Consortium, Inc.
113 West G Street, Suite 444
San Diego, CA 92101
Phone/Fax: 619-795-3602
ravillabayridge@cs.com
www.ravillabayridge.com

REFERENCES

Ackerman, K. B. (2017). Examining the efficacy of co-teaching at the secondary level: Special educators' perceptions of their productivity as co-teachers (Order No. 10628780). Available from Dissertations & Theses @ University of Kentucky; ProQuest Dissertations & Theses Global. (1922583177)

Baurhoo, N., & Asghar, A. (2014). Using universal design for learning to construct inclusive science classrooms for diverse learners. Learning Landscapes, 7(2), 59-81.

Bogdan, R., & Biklen, S. K. (2007). Qualitative research for education: An introduction to theory and methods (5th ed.). Pearson.

Brigham, F. J., Scruggs, T. E., & Mastropieri, M. A. (2011). Science education and students with learning disabilities. *Learning Disabilities Research & Practice (Wiley-Blackwell), 26*(4), 223–232.

CAST. (2018). Universal Design for Learning Guidelines version 2.2. Retrieved from http://udlguidelines.cast.org

Center for Multilevel Modeling (n.d.). Mann-Whitney tests in SPSS. The British Academy.

Council for Exceptional Children. (2014). Council for Exceptional Children standards for evidence-based practice in special education. Retrieved from http://www.cec.sped.org/~/media/Files/Standards/Evidence%20based%20Practices%20and%20Practice/CECs%20Evidence%20Based%20Practice%20Standards.pdf

Cook, B.G., & Cook, S.C. (2011). Unraveling evidence-based practices in special education. *The Journal of Special Education, 47*(2), 71-82.

Cook, L., & Friend, M. (1995). Co-Teaching: Guidelines for creating effective practices. *Focus on Exceptional Children. 28*(3), 1-16.

Cramer, E., & Nevin, A. (2006). A mixed methodology analysis of co-teacher assessments. *Teacher Education and Special Education, 29*(4), 261-274.

Creswell, J.W. (2012). *Educational research: Planning, conducting, and evaluating quantitative and qualitative research* (4th Ed.). Pearson.

Dalton, B., Morocco, C.C., Tivnan, T., & Rawson Mead, P.L. (1997). Supported inquiry science: Teaching for conceptual change in urban and suburban classrooms. *Journal of Learning Disabilities, 30,* 670-684.

Dexter, D.D., & Hughes, C.A. (2011). A meta-analytic review of graphic organizers

and science instruction for adolescents with learning disabilities: Implications for the intermediate and secondary science classroom. *Learning Disabilities Research & Practice, 26*(4), 204-213.

Dieker, L., & Rodriguez, J. (2013). Enhancing secondary cotaught science and mathematics classrooms through collaboration. *Intervention in School and Clinic, 49*(1), 46-53.

Dymond, S. K., Renzaglia, A., Rosenstein, A., Eul Jung Chun, Banks, R. A., Niswander, V., & Gibson, C. L. (2006). Using a Participatory Action Research Approach to Create a Universally Designed Inclusive High School Science Course: A Case Study. *Research & Practice for Persons with Severe Disabilities, 31*(4), 293–308. https://doi.org/10.1177/154079690603100403

Eick, C.J., Ware, F.N., & Williams, P.G. (2003). Coteaching in a science methods course: A situated learning model of becoming a teacher. *Journal of Teacher Education, 54*(1), 74-85.

Emerson, R.M., Fretz, R.I., & Shaw, L.L. (1995). Writing Ethnographic Fieldnotes. Second Edition. London, UK: The University of Chicago Press.

Fenty, N. S., McDuffie-Landrum, K., & Fisher, G. (2012). Using collaboration, co-teaching, and question answer relationships to enhance content area literacy. *Teaching Exceptional Children, 44*(6), 28–37.

Gately, S.E., & Gately, Jr., F.J. (2001). Understanding coteaching components. *Teaching Exceptional Children. 33*(4), 40-47.

Guise, M., Habib, M., Thiessen, K., & Robbins, A. (2017). Continuum of co-teaching implementation: Moving from traditional student teaching to co-teaching. *Teaching and Teacher Education, 66,* 370-382.

Haimowitz, B. S. (2018). Self-perceived teacher attitudes about inclusion and the implementation of co-teaching models in the elementary school classroom (Order No. 10790289). Available From ProQuest Dissertations & Theses Global. (2034429880).

Heward, W.L., Alber-Morgan, S.R., & Konrad, M. (2017). Exceptional children: An introduction to special education. Boston, MA: Pearson.

Hines, J. T. (2008). Making collaboration work in inclusive high school classrooms: Recommendations for principals. *Intervention in School & Clinic, 43*(5), 277–282.

Hott, B.L., Berkeley, S.L., Raymond, L.P., & Reid, C.C. (2018). Translating intervention research for students with mild disabilities to practice: A systemic journal analysis. *The Journal of Special Education, 52*(2), 67-77.

Individuals with Disabilities Education Act, 20 U.S.C. § 1400 (2004).

Lava, V.F. (2012). Inquiry into co-teaching in an inclusive classroom. *I.E.: Inquiry in Education, 3*(2), Article 5. Retrieved from: https://digitalcommons.nl.edu/ie/vol3/iss2/5/

Lave, J. & Wenger, E. (1991). *Situated Learning: Legitimate Peripheral Participation*. New York, NY: Cambridge.

Lewis-Beck, C. & Lewis-Beck, M. (2015). *Applied regression: An introduction*. (2nd Ed). SAGE Publications.

Linz, E., Heater, M. J., & Howard, L. (2008). Team teaching high school science: Game plan for success. *Teaching Exceptional Children Plus 5*(2) Article 2.

Kahn, S., & Lewis, A.R. (2014). Survey on teaching science to k-12 students with disabilities: Teacher preparedness and attitudes. *Journal of Science Teacher Education, 25*(8)*,* 885-910.

Kentucky Department of Education. (2020, June 6). *Kentucky Education Facts*. https://education.ky.gov/comm/edfacts/Pages/default.aspx

King-Sears, M.E., Brawand, A.E., Jenkins, M.C., Preston-Smith, S., (2014). Co-teaching perspectives from secondary science co-teachers and their students with disabilities. *Journal of Science Teacher Education, 25*. 651-680

Korthagen, F.A.J. (2010). Situated learning theory and the pedagogy of teacher education: Towards an integrative view of teacher behavior and teacher learning. *Teaching and Teacher Education, 26,* 98-106.

Krithikadatta, J. (2014). Normal distribution. *Journal of Conservative Dentistry, 17*(1), 96-97.

Maeng, J. L., & Bell, R. L. (2015). Differentiating Science Instruction: Secondary science teachers' practices. *International Journal of Science Education, 37*(13), 2065–2090.

Malian, I., & McRae, E. (2010). Co-Teaching beliefs to support inclusive education: Survey of relationships between general and special educators in inclusive classes. Electronic Journal for Inclusive Education, 2 (6).

Mastropieri, M.A., & Scruggs, T.E. (2010). *The inclusive classroom: Strategies for effective differentiated instruction* (6th Ed.). Pearson.

McLeskey, J. (2017). *High-leverage practices in special education*. Council for Exceptional Children.

Mcduffie, K.A., Mastropieri, M.A., Scruggs, T.E. (2009). Differential effects of peer tutoring in co-taught and non-co-taught classes: Results for content learning and student-teacher interactions. *Exceptional Children, 75*(4), 493-510.

Merriam, S.B. (1998) *Qualitative Research and Case Study Applications in Education.* San Francisco, CA: Jossey-Bass.

Minthrop, H., & Zane, R. (2017). When the achievement gap becomes high stakes for special education teachers: Facing a dilemma with integrity. *Teachers College Record, 119*(9), 1–39.

Moorehead, T., & Grillo, K. (2013). Celebrating the Reality of Inclusive STEM Education. *Teaching Exceptional Children, 45*(4), 50–57. https://doi.org/10.1177/004005991304500406

Mumba, F., Banda, A., & Chabalengula, V.M. (2015). Chemistry teachers' perceived benefits and challenges of inquiry-based instruction in inclusive chemistry classrooms. *Science Education International, 26*(2), 180-194.

Murawski, W.W., & Swanson, H.L. (2001). A meta-analysis of co-teaching research. Where are the data? *Remedial and Special Education, 22*(5), 258-267.

National Center for Education Statistics. National Assessment of Educational Progress (NAEP). Ann Arbor, MI: [distributor], 2015-01-26.

Noonan, M.J., McCormick, L., & Heck, R.H. (2003). The co-teacher relationship scale:

Applications for professional development. *Education and Training in Developmental Disabilities, 38*(1), 113-120.

Phelan, Michelle P. (2018). General education science and special education teachers' experiences with inclusive middle school science classrooms. *Dissertation Abstracts International*, Vol.79(9-A(E)).

Ploessl, D., Rock, M. L., Schoenfeld, N. A., & Blanks, B. (2010). On the same page: Practical techniques for enhancing co-teaching interactions. *Intervention in School and Clinic, 45*(3), 158-168.

Price, J.F., Johnson, M., & Barnett, M. (2012). Universal design for learning in the science classroom. In Hall, T.E., Meyer, A., & Rose, D.H. (ED.). *Universal Design for Learning in the Classroom: Practical Applications* (pp. 55-70). The Guilford Press.

Ricci, L.A., Persiani, K., Williams, A.D., & Ribas, Y. (2019). Preservice general educators using co-teaching models in math and science classrooms of an urban teacher residency programme: Learning inclusive practices in teacher training. *International Journal of Inclusive Education,* DOI: 10.1080/13603116.2018.1563643

Rice, D. (2017). Elementary general education teachers' knowledge of and experience teaching students with disabilities in science and social Studies. Dissertation Abstracts International Section A: Humanities and Social Sciences. ProQuest Information & Learning. Retrieved from http://search.ebscohost.com.ezproxy.uky.edu/login.aspx?direct=true&db=psyh&AN=2016-47709-143&site=ehost-live&scope=site

Riedell, K. E. (2017). Understanding curriculum, instruction and assessment within eighth grade science classrooms for special needs students. Dissertation Abstracts

International Section A: Humanities and Social Sciences. ProQuest Information & Learning. Retrieved from http://search.ebscohost.com.ezproxy.uky.edu/login.aspx?direct=true&db= psyh& AN=2017-10860-042&site=ehost-live&scope=site

Russo-Campisi, J. (2017). Evidence-based practices in special education: Current assumptions and future considerations. *Child & Youth Care Forum, 46*(2), 193-205.

Schulte, A. C., & Stevens, J. J. (2015). Once, sometimes, or always in special education: Mathematics growth and achievement gaps. *Exceptional Children, 81*(3), 370–387.

Scruggs, T.E., & Mastropieri, M.A. (2000). The effectiveness of mnemonic instruction for students with learning and behavior problems: An update and research synthesis. *Journal of Behavioral Education, 10*(2/3), 161-173.

Scruggs, T.E., Matropieri, M.A., & McDuffie, K.A. (2007). Co-teaching in inclusive classrooms: A metasynthesis of qualitative research. *Exceptional Children, 73*(4), 392-416.

Seidman, I. (2006). Interviewing as Qualitative Research: A Guide for Researchers in Education and Social Sciences. Third Edition. New York, NY: Teachers College Press.

Simon, B. D. (2018). Successful collaboration between general education and special education teachers: A case study. Dissertation Abstracts International Section A: Humanities and Social Sciences. ProQuest Information & Learning.

Skiba, R.J., Simmons, A.B., Ritter, S., Gibb, A.C., Rausch, M.K., Cuadrado, J., & Chung, C-G. (2008). Achieving equity in special education: History, status, and current challenges. *Exceptional Children (74)* 4, 264-288.

Stenhoff, D.M., & Lignugaris/Kraft, B. (2007). A review of the effects of peer tutoring on students with mild disabilities in secondary settings. *Exceptional Children, 74*(1), 8-30.

TeachingWorks (2020). Eliciting and interpreting student thinking. *TeachingWorks Resource Library*. http://www.teachingworks.org/work-of-teaching/high-Leverage-practices.

The HLP Writing Team (2017). High-leverage practices in special education. *Council for Exceptional Children*. https://highleveragepractices.org/about-hlps/.

Therrien, W. J., Taylor, J. C., Hosp, J. L., Kaldenberg, E. R., & Gorsh, J. (2011). Science Instruction for Students with Learning Disabilities: A Meta-Analysis. *Learning Disabilities Research & Practice (Wiley-Blackwell), 26*(4), 188–203

Thornton, A., McKissick, B. R., Spooner, F., Ya-yu Lo, & Anderson, A. L. (2015). Effects of collaborative preteaching on science performance of high school students with specific learning disabilities. *Education & Treatment of Children*, 38(3), 277–304.

Tomlinson, C.A. & Imbeau, M.B. (2010) Leading and Managing a Differentiated Classroom. Alexandria, Va: ASCD.

U.S. Department of Education, Office for Civil Rights. (2010) *Free appropriate public education for students with disabilities: Requirements under Section 504 of the Rehabilitation Act of 1973.* ED Pubs.

Van Garderen, D., Hanuscin, D., Lee, E., & Kohn, P. (2012). QUEST: A collaborative professional development model to meet the needs of diverse learners in K-6 Science. *Psychology in the Schools, 49*(5), 429–443.

Villa, R., Thousand, J., & Nevin, A. (2013). A guide to co-teaching: Practical tips for facilitating student learning. Thousand Oaks, CA: Corwin Press.

Walther-Thomas, C.S. (1997). Co-teaching experiences: The benefits and problems that teachers and principals report over time. *Journal of Learning Disabilities, 30*(4), 395-407.

Watt, S. J., Therrien, W. J., Kaldenberg, E., & Taylor, J. (2013). Promoting inclusive practices in inquiry-based science classrooms. *Teaching Exceptional Children, 45*(4), 40–48.

Weiss, M.P., & Rodgers, W.J. (2020). Instruction in secondary cotaught classrooms: Three elements, two teachers, one unique approach. *Psychology in the Schools, 57*(6), 959-972.

Wenger, E. (1998). *Communities of Practice: Learning, Meaning, and Identity.* New York, NY: Cambridge.

Windschitl, M., Thompson, J., Braaten, M., & Stroupe, D. (2012). Proposing a core set of instructional practices and tools for teachers of science. *Science Education, 96*(5), 878-903.

Wolgemuth, J.R., Cobb, R.B., & Alwell, M. (2008). The effects of mnemonic interventions on academic outcomes for youth with disabilities: A systematic review. *Learning Disabilities Research & Practice, 23*(1), 1-10.

VITA

Academic Degrees and Preparation

Ph.D. Expected 2021: University of Kentucky, Education Sciences, STEM Education Strand, Advisor: Dr. Jennifer Wilhelm.

MAT (2017): University of Louisville, Secondary Science Education

B.S. (2013): Radford University, Chemistry and Biology

Professional Experience

2021–Present	Alice Lloyd College	Associate Professor of Education
2018-2021	University of Kentucky	Graduate Assistant
2017-2018	Shelby County High School	Integrated Science Teacher
2016-2017	North Oldham High School	Chemistry and Biology Teacher
2015-2016	Nelson County High School	Chemistry, AP Chemistry Teacher

Paper Presentations

Krall, R[1]., Ringl, S[1]., & Criswell, B[2]. Professional noticing as a tool for developing a shared vision of pedagogical practice in science. *Presentation at the annual meeting of the Association for Science Teacher Education,* ASTE, Salt Lake City, UT (January 13-16, 2021) [Conference Held Virtually].

Krall, R., Criswell, B., & Ringl, S. How do secondary science teacher candidates' noticing skills develop in the context of their methods courses? *Presentation at the annual meeting of the National Association for Research in Science Teaching,* NARST, Portland, OR (March 15-18, 2020) [Conference Cancelled].

Ringl, S. Differentiation in secondary science classrooms. *Presentation at the Spring Research Conference,* Cincinnati, OH (March 7, 2020).

Wilhelm, J., Cole, M., Driessen, E., Yesilyurt, E., Huerta, M., Higgens, Hightower, A., Jones, J., Gonzalez-Napoleoni, J., & Ringl, S. Spatial-Scientific

snapshots of middle level students' lunar understanding. *Presentation at the annual meeting of the School Science and Mathematics Association,* SSMA, Salt Lake City, UT (November 7-9, 2019).

Ringl, S., & Krall, R. Effect of classroom video analysis on noticing abilities in secondary science pre-service teachers. *Presentation at the Spring Research Conference,* Lexington, KY (March 2, 2019).

Submitted Scholarly Works

Criswell, B., Krall, R., & Ringl, S (2020). *Video analysis and professional noticing in the wild of real science teacher education class.* Manuscript submitted for publication.

Wilhelm, J., Cole, M., Driessen, E., Ringl, S., Hightower, A., Huerta, M., Gonzalez-Napolieoni, J., Jones, J., & Yesilyurt, E. (2020). *Middle school students' contextualized spatial understandings after studying moon phases: A comparison of two geographic locations.* Manuscript submitted for publication.

Manuscripts in Preparation

Krall, R., Ringl, S., & Criswell, B. (2020). *Effect of classroom video analysis on noticing abilities in secondary science pre-service teachers.* Manuscript in preparation.

Ringl, S. (2020). *Inclusive strategies for students with disabilities in secondary co-taught science classrooms.* Manuscript in preparation.